DOCUMENT RESUME

ED 399 141 SE 057 910

AUTHOR	Horton, Robert L.; And Others
TITLE	Soils Alive! From Tiny Rocks to Composting. Cycling Back to Nature.
INSTITUTION	National 4-H Council, Chevy Chase, MD.
SPONS AGENCY	Cooperative State Research, Education, and Extension Service (DOA), Washington, DC.
PUB DATE	95
NOTE	58p.
AVAILABLE FROM	National 4-H Council, 7100 Connecticut Avenue, Chevy Chase, MD 20815.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Demonstrations (Science); Elementary Secondary Education; Environmental Education; *Natural Resources; Science Activities; *Soil Conservation; *Soil Science
IDENTIFIERS	Environmental Action; Environmental Awareness

ABSTRACT

This environmental sourcebook contains activities focusing on the living and nonliving components of soil and their relationship to the earth's natural cycles. The materials contained in this guide are for use with youth ages ten and older and are designed to stimulate a sense of stewardship for the environment through group discussion, role playing, experimentation, demonstration, and simulation. The material starts with the tiny rocks and other inorganic materials found in the soil. From there the curriculum progresses through organic materials, interdependencies, and composting. The five chapters are: (1) "Rocky Beginnings: Soil's Non-Living Components"; (2) "Soil Boosters: Soil's Organic Components"; (3) "Don't Eat Those Mudpies: Soil's Living Components"; (4) "From Soil to Supper: Our Reliance on Soil Organics"; and (5) "Cycling Back to Nature: With Organic Residue." Contains a brief resource list and glossary. (JRH)

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ENVIRONMENTAL STEWARDSHIP

Cycling Back to Nature

ED 399 141

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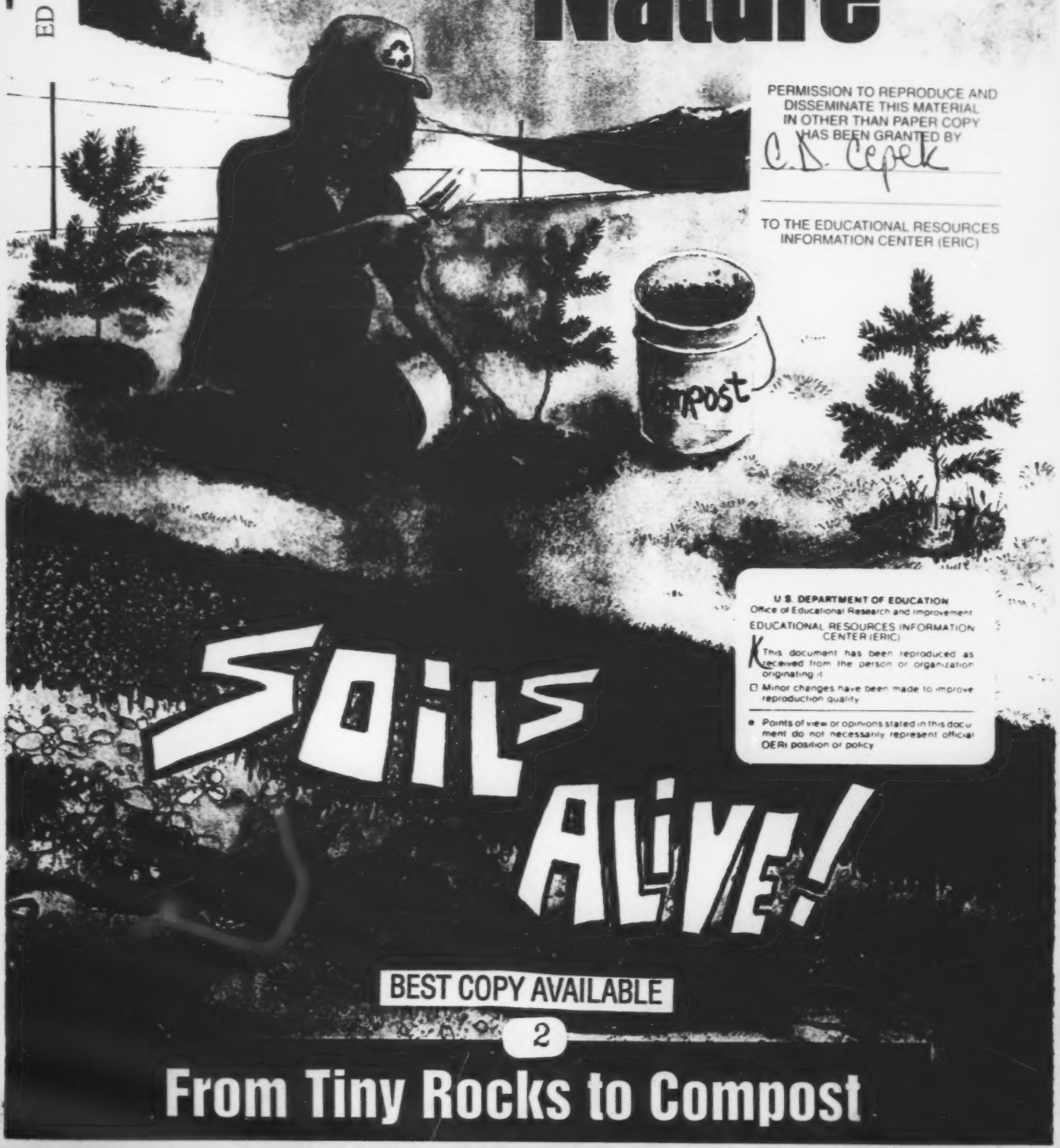

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Soils Alive!

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From Tiny Rocks to Compost

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Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914.

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SOILS ALIVE!

FROM TINY ROCKS TO COMPOSTING CYCLING BACK TO NATURE

An environmental sourcebook of activities focusing on the living and nonliving components of soil and their relationship to the earth's natural cycles.

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This material is based upon work supported by the Cooperative State Research, Education and Extension Service, U.S. Department of Agriculture, National 4-H Council, and National Center for Science Teaching and Learning. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and the technical review committee and do not necessarily reflect the views of the sponsoring organizations.

Acknowledgments

Special thanks to Novon-Warner-Lambert and Monsanto The Agriculture Group for financial and technical assistance.

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WELCOME!

The 4-H Environmental Stewardship program is designed to foster responsibility for the future among youth. The program encourages young people to recognize and appreciate the earth's limited resources, from wetlands to forests to prairies. The earth's finite riches include the fragile layer of topsoil covering the earth's surface. This topsoil contains living organisms, dead plant and animal material, and nutrients that are essential to life as we know it on the planet.

One of the subjects emphasized in *Soils Alive!* is the misdirection of organic materials away from the soil. These valuable materials, including food scraps, soiled papers, animal bedding, and yard trimmings, often end up in landfills. Unfortunately, landfills are not in the business of returning decomposed organic material back to the soil. What goes into a landfill is entombed there indefinitely. It is prevented from returning to the earth's natural system. For many communities, landfilling organic materials is an issue of great debate. There is no one easy way to ensure that organic materials end up back in the soil rather than in a landfill. Rather, the appropriate solution depends on the local situation.

In *Soils Alive!* we provide an opportunity for you and others to examine the concepts and issues related to soils and soil organics. We create a learning environment that blends critical thinking with exploration of the environment. The activities in *Soils Alive!* are experience-based. This encourages participants to explore, reflect, and apply the knowledge and skills acquired. Our goal is to produce better informed and responsive decision makers for the future!

OUTLINE OF BOOK

This leaders' guide is organized so, like nature's cycles, concepts are interlocking and overlapping.

1 ROCKY BEGINNINGS
SOIL'S NONLIVING COMPONENTS 5

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Discuss With the Group 6
Introduce soils, including an examination of the inorganic components.

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2 SOIL BOOSTERS
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3 DON'T EAT THOSE MUDPIES
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Help participants understand that various living organisms exist and work in different ways in topsoil. Each kind of organism plays a particular role in the decomposition of plant and animal matter.

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5 CYCLING BACK TO NATURE ...
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ABOUT THE CHAPTERS

The materials contained in this guide are for use with youth ages ten and older. They are designed to stimulate a sense of stewardship for the environment through group discussion, role playing, experimentation, demonstration, and simulation. Most require easily obtainable materials and a minimal amount of preparation time, making them ideal for volunteer leaders with limited resources. Other lessons are longer and require more preparation, but are worth it in the long run. Preparation time is listed on activities where time is required beyond the normal amount needed to gather materials.

The material starts, literally, with the tiny rocks and other inorganic materials found in soil. From there the curriculum progresses through organic materials, interdependencies, and composting. We've tried to show how human actions affect our soils and our ability to survive on our planet.

Chapters may be used individually or in sequence as a comprehensive unit of study. Activities within chapters vary in complexity and sophistication, so you may choose among them to suit the learners. When preparing each lesson, review the background and activities a few days in advance. Gather the materials and practice the experiments beforehand. Feel free to improvise if the suggested materials are not available.

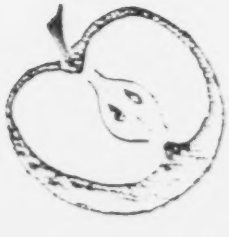
It's also a good idea to familiarize yourself with the "Discuss With the Group" and "Bringing It Home" sections. The former helps youth prepare for the learning. The latter, along with "Guiding Questions," helps students relate what they observed and experienced to real life situations.

Try not to focus on answers being right or wrong. Rather, accept all reasonable answers as possible solutions. And remember, it's not important that you know all the answers. Be a resource to group members, helping them identify sources of further information. Remember, it's more important to help youth learn how to think, than what to think! By developing their critical thinking skills, youth are exercising their minds, creativity, and individuality!

Try to schedule at least one hour for each lesson and include a minimum of two activities. Time permitting, you may wish to explore some of the "Digging Deeper" activities. Also consider doing some of the "Going Beyond" activities to provide a bridge between lessons. Conceivably, you could provide participants with an excellent background in soils, minerals, and composting in as little as six hours, or just four to six meetings!

Your work as a volunteer leader or educator will help protect the precious soil resources of the earth. Plants need soil to grow, and we depend upon plants for life. As we face the future challenges of feeding the planet's growing population, soil fertility will become an increasingly urgent concern. By helping young people understand the things that affect soil productivity, you are helping to feed the world.

Finally, remember to practice what you preach! The materials used in activities, including apple peels, papers, and vegetation, should be composted, reused, or recycled!



TEACHING OUTLINE

We suggest you include the following in each lesson:

Review of Last Session — review what participants learned at the last session. This will create a common starting place for the current session and smooth the flow into the new information.

Introduce New Knowledge — Rely heavily on showing rather than telling, eliciting responses, and listening. Refer to the activities in each lesson or use your own to get the key concepts across. Italicized words found throughout the book may be new to students. A glossary in the back helps fill in any definitions needed.

Summarize Learning — Have participants talk about what they learned, how it could be applied elsewhere, and what they liked doing. Focus on the positive, especially when things don't work out as you planned!

Bring Closure to the Session — Provide an overview of what will be covered during the next session. Build excitement for what's to come by giving group members a problem to solve or a question to answer between sessions.

ROCKY BEGINNINGS

1

... SOIL'S NONLIVING COMPONENTS

KEY CONCEPTS

- *Soil* consists mostly of inorganic solids such as rocks and minerals.
- Rocks generally are made of two or more minerals, although some, like quartzite (quartz) and marble (calcite) contain only one mineral.
- *Minerals*, solid uniform chemical elements or compounds made by nature, move in the environment in cycles.

Background

The earth's crust is made of rocks and minerals that are called *inorganic* solids—materials not originating from animals or plants—and a thin layer of vegetation and other *organic* materials.

For millions of years wind, rain, ice, heat, gravity, and chemicals have carved away at the crust, creating material we know as soil. The particles of rock present in soil range in size from large, coarse sand to fine clay particles. Soil, where it exists, may be many feet deep.

The inorganic part of soils is derived from *parent material*—rocks, boulders, etc. Soils mainly made from the weathered fragments of solid rock beneath are called *residual soils*. Soils made from fragments of rock carried by streams, waves, winds, or glaciers are called *transported soils*.

Some parent materials, such as the quartz in sandstone, resist weathering. In these cases, the soils develop slowly, contain course grains, and tend to be chemically similar to the parent material. In most soils, however, minerals from the parent material are broken down relatively quickly. So in the short run, organic activity and climate have far more influence on the nature of the soil than the parent material.

WORDS TO KNOW

Cleavage
Element
Hardness
Horizon
Igneous rock
Inorganic
Metamorphic rock
Mineral
Nutrient
Organic
Parent material
Residual soil
Sedimentary rock
Soil
Topsoil
Transported soil

Discuss With the Group

Before you do the activities, discuss the inorganic parts of soils—rocks and minerals. Show participants samples of *topsoil*, rocks, and minerals. Topsoil is the surface layer of soil, including decaying roots and other organic material. Explain to participants that they will be exploring how rocks and minerals form the nonliving part of soil. Be sure to differentiate between once-living but dead and never-living. By nonliving, we mean never-living. There are many things in the soil that are dead but once were alive. These are organic materials, and will be explored in future lessons.

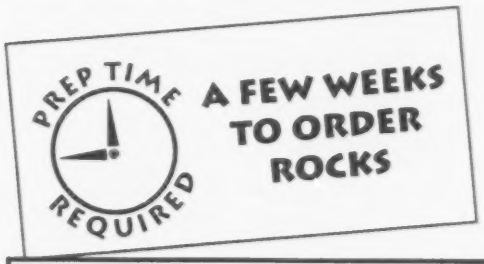
Explain the nature of minerals in the various *horizons* (layers) of soil, referring to the following illustration. (The activity *Digging for Answers* also contains related information.) Stress the importance of minerals in the fragile layer of topsoil and how plant and animal life rely on these *nutrients* for their existence. For example, the calcium in our teeth and bones originally came (via our food) from the rocky crust of the planet!

MATERIALS

- Shoe box with topsoil
- 10 to 15 rocks and minerals

RESOURCES

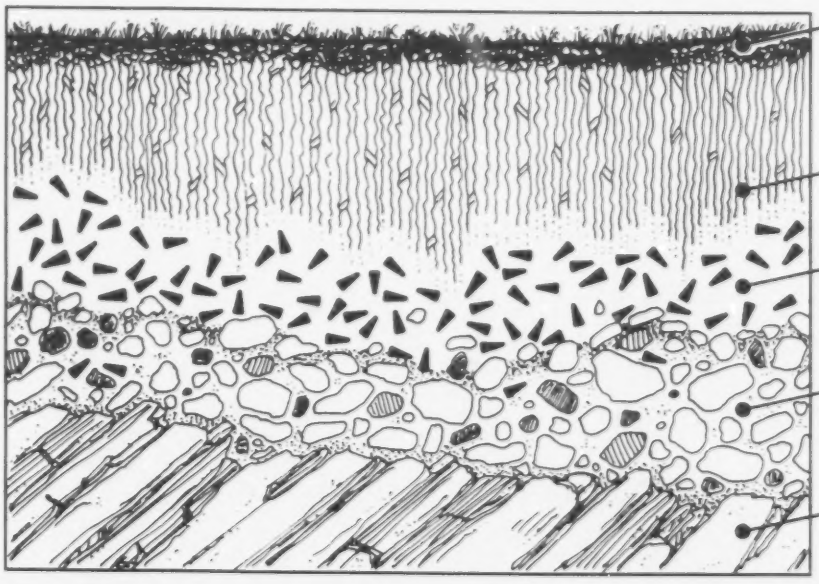
Inexpensive collections of rocks and minerals can be purchased from NASCO. To order or request a catalog, call 1-800-558-9595.



A FEW WEEKS TO ORDER ROCKS

Soil Profiles

If you cut down through the soil to the bedrock below, you would see a soil profile. In many profiles, you can identify about five layers, or horizons. Each of these is given a letter, starting with O and running down through A, B,C, and D. This illustration shows a fairly typical profile.



The O horizon is a thin layer of humus (dead leaves and other organic matter). It contains micronutrients and minerals.

The A horizon is topsoil, dark and rich in humus and minerals.

The B horizon is subsoil, poorer in humus but rich in minerals from the topsoil.

The C horizon is unfertile, weathered rock fragments that contain a blend of minerals.

The D horizon is unfertile, solid bedrock also containing a blend of minerals.

APPLE EARTH

MATERIALS

- Small apples
- Plastic knives
- Caramel for dipping (optional)

Use this activity to stress the importance of soil as a resource. Give each participant an apple and knife. Explain that the apple represents the earth. They will use the apple to think about soils from a planetary perspective.

1. Have participants cut their apples lengthwise in four equal parts. Explain that three of these parts represent the portion of the earth covered by water. The remaining quarter represents land. Have participants cut it in half widthwise. Explain that one of these halves represents the area of the earth that is desert, tundra, and swamps.
2. Have participants cut the remaining half portion into four equal parts. Explain that three of the parts represent the area of the earth that has mountains, forests, housing, and industry. This land cannot be used to grow agricultural crops.
3. Explain that the fourth portion (1/32nd of original apple) represents the land suitable for growing food and fiber crops.
4. Next, have group members peel the skin off this section. Explain that the skin represents the topsoil usable for producing crops.
5. Have the group eat their apple pieces while completing the "Bringing It Home" and "Guiding Questions" sections. You may want to provide caramel for dipping!

Bringing It Home

Have participants hold up the pieces of apple that represent the earth's cultivated land and land used by people. Discuss how people and nature have changed the planet. They may want to make two fists. One would represent change caused by people (e.g., soil erosion, harvesting of forests) and the other would represent change by nature (e.g., volcanoes, earthquakes, hurricanes, glaciers).

Guiding Questions

Q If topsoil is washed or blown away, can it be replaced? (Not in the short term.)

Q What happens if organic matter such as the apple is not returned to the soil? (The quality of the soil could eventually decrease.)

Q Which has greater impact on the soil—people or nature? (This is a question with no clear right or wrong answer. Both nature and people can create catastrophic events. Erosion of soils and weathering of rocks are activities only nature can undertake, although humans can affect the degree of erosion. Let participants debate this question.)

ACTIVITY

THE MINERAL CYCLE

Have participants look closely at pieces of rocks. They will see that they are not completely smooth, like plastic or metal. Instead, like a sugar cube, they are made up of crystals. These crystals, which are sometimes small and sometimes large, are called minerals. A mineral is a combination of elements. There are about 2,000 kinds of minerals, but only 100 of them are common. All rocks are made up of minerals. Explain that almost all minerals expand in liquids. For example, some minerals grow in a liquid called magma. This extremely hot substance contains all the elements that make up the earth's minerals. When magma cools, some elements bond together and form tiny mineral crystals. The mineral crystals grow by adding layers of elements to their flat surfaces. Distribute copies of Activity Sheet 1.1. Explain to participants how minerals originate from the earth's surface or from deeper down through volcanic activity. Let participants draw arrows from the volcano, where minerals are blasted into the air, to the land, where they settle and are incorporated into the soil. They also may draw arrows from the land, where minerals are washed away, to the seas, where they settle out on the sea floor or remain dissolved in water. Using hand lenses, let group members examine samples of different minerals. Have them describe the samples and discuss what makes them different from each other (size, shape, weight, color, etc.).

Bringing It Home

Have group members research and discuss some of the more common minerals in the soil (e.g., calcium, garnet, graphite, gypsum, olivine, iron, salt). A rock and mineral identification book is a good place to start. Or, youth also can work in small teams to generate a list of nonliving things found in the soil, including common minerals.

Guiding Questions

Q Do minerals play an important role in the makeup of the soil? (Yes, when mixed with liquid, they are what plants depend on for growth and nutrition.)

Q How do plants get the minerals they need to survive? (They absorb them from the soil.)

Q How do people get the minerals they need to grow? (By eating plants and plant-eating animals.)

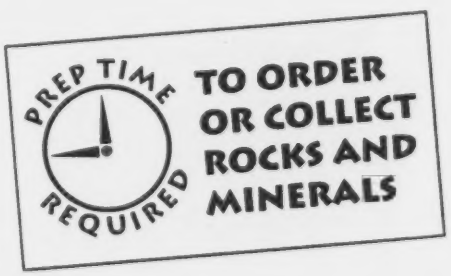
Q Is coal a mineral? (No! Coal is formed from the ancient remains of animals and plants—it isn't inorganic!)

MATERIALS

- Copies of Activity Sheet 1.1
- Mineral samples (order from NASCO, a science museum or a rock store, or try collecting your own!)
- Hand lenses

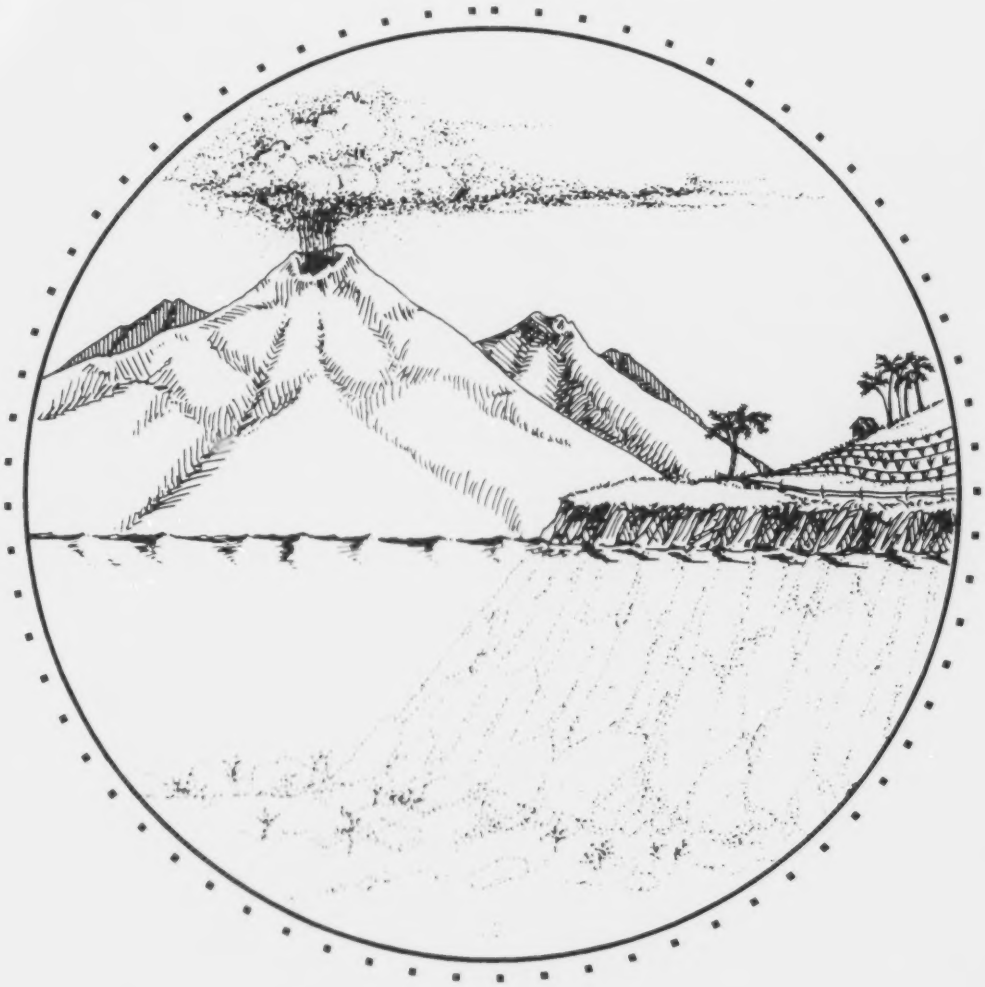
DID YOU KNOW?

The word *element* comes from the Latin word 'elementum.' It originally referred to the four basic substances that ancient Romans thought comprised the universe—fire, water, earth, and air. Today, we define an element as a substance that cannot be separated by chemical means into other substances. There are more than 100 known elements. Some of the more common elements are iron, nickel, copper, aluminum, sulfur, lead, and mercury.



The Mineral Cycle

Minerals originate from the earth's surface or from deeper down through volcanic activity. Draw a line from where minerals are blasted into the air to the land where they settle and to the soil where they are absorbed. Also draw an arrow from where minerals are washed away to where they settle (or remain dissolved).



DIGGING DEEPER

MINERAL COMPARISONS

As you might suspect, minerals vary greatly in appearance and feel. Some have glass-like surfaces that sparkle with color. Others look dull and feel greasy. Hard minerals such as diamonds can scratch glass. The softest ones can be scratched by a fingernail! Minerals are identified by their color, luster, streak, *cleavage*, *hardness*, and special properties. The following are characteristics of some common minerals.

Mineral	*Color*	*Luster*	*Streak*	*Hardness*	*Properties*
Calcite	white	glassy	white	3	fizzes with acid
Feldspar	white pink	glassy	white pink	6	splits into pieces with flat surfaces
Fluorite	pale purple	glassy	white	4	cubic crystals
Gypsum	white yellow	variable	white	2	powdery
Halite	colorless	glassy	white	2.5	salty taste
Hematite	gray red	dull	dark red	6	kidney shape lump
Hornblende	dark green	glassy	pale gray	5.5	breaks along three planes
Magnetite	iron black	metallic	black	6	magnetic
Malachite	bright green	dull	pale green	3.5	distinctive color
Mica	silvery black	glassy	white	2.5	flaky
Olivine	olive green	glassy	white gray	6.5	looks like hornblende
Quartz	milky	glassy	white	7	looks like glass

Depending on interest, let participants explore the various types of minerals. They may wish to perform hardness, streak, and chemical tests to identify the minerals. Ask your librarian for a book on minerals that explains how to conduct these tests.

Mohs Hardness Scale

Mineral	*Hardness*	*Scale*
Talc	1	Scratched by fingernail
Gypsum	2	Scratched by fingernail
Calcite	3	Scratches a copper coin
Fluorite	4	Scratches a knife blade or glass
Apatite	5	Scratches a knife blade or glass
Feldspar	6	Scratches a knife blade or glass
Quartz	7	Scratches a knife blade or glass
Topaz	8	Scratches a knife blade or glass
Corundum	9	Scratches a knife blade or glass
Diamond	10	Scratches all common materials

MATERIALS

- Assortment of minerals
- Mineral test kit (order from NASCO or other source)

TO ORDER OR COLLECT MINERALS AND TEST KIT

BIO-NOTE

Some Australian university students discovered the world's oldest rocks. The rocks contain tiny crystals of zircon embedded in sandstone. They are more than 4.2 billion years old!

LOOKING AT ROCKS

ACTIVITY

MATERIALS

- Samples of rocks and soil from your yard
- Copies of Activity Sheet 1.2
- Samples of metamorphic, igneous, and sedimentary rocks—order from NASCO or others (see previous pages)
- Pictures of rocky landscapes (optional)

Continue your exploration of soil with a discussion about rocks. Begin by mentioning that whenever you dig into soil, you always seem to turn up rocks. Bring in samples of rocks and soil you've dug up, or ask participants to dig in their own yards to supply samples. Everyone should examine the shape and sizes of the rocks. How did they get into the soil? Which came first, the soil or the rock? (No one really knows, but everyone is likely to have some good guesses and discussions!)

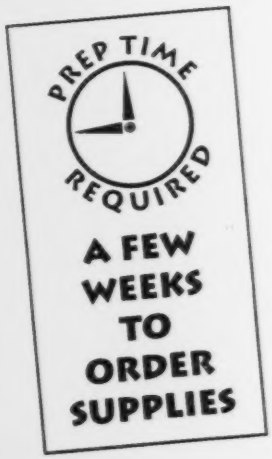
Point out that rocks come from minerals. They are made in one of three ways. *Igneous rocks* are cooled from the molten magma that erupts from deep inside the earth's hot interior. *Sedimentary rocks* are made when sediments (small pieces of rocks, soil, and other matter) settle out of water and are squeezed and cemented until solid. *Metamorphic rocks* are created from existing material by the tremendous heat of molten magma or the crushing forces that build mountains.

Give each participant a copy of Activity Sheet 1.2 and a sample of each of the three rock types. Have participants examine their rocks and complete the sheets. Let them share their answers with the group.

Bringing It Home

Discuss the three types of rock found in nature and their unique characteristics. Sometimes pictures of rocky landscapes will stimulate discussion, especially if you are trying to help them visualize the origin of their rock samples.

For added fun, have participants stand in a circle. Place a collection of rocks in the center of the circle. Have each person select a rock. Give everyone a few minutes to look at the rock carefully. Each person should then pass the rock to the right. Continue passing rocks to the right. Now let everyone change positions randomly. After three or four more passes, tell the group that the object of this game is for them to get their rock back. Let the rock race begin! Everyone must stand where they are and pass rocks until they find their original. They can then sit down. The game ends when everyone is seated. Can they name the types of rocks they have in their hands (sedimentary, igneous, metamorphic)?



Guiding Questions

Q Are all rocks alike? (No, there are three categories.)

Q Can soil be turned back into rock? (Yes, minerals—sandstone and limestone—are excellent examples.)

Q Which type of rocks are the prettiest, in general? (Marble, granite, and obsidian, but remember that beauty is in the eye of the beholder!)

Q Which igneous rock is the lightest? (Pumice.)

Q Do some rocks look like they have minerals in them? (Yes—some rocks, such as quartz, marble, etc. will have small sparkling specks or flecks of color.)

ACTIVITY SHEET 1.2 — A LOOK AT ROCKS

Carefully examine one rock from each of the three types, then answer the questions below:

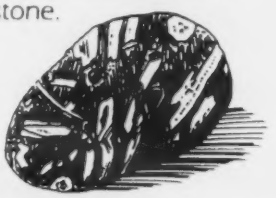
Name of Rock:

Description:
(see list on bottom of page for help)

Draw your rock here

Metamorphic

Metamorphic rocks are altered rocks, formed when heat, pressure and sometimes natural chemicals reshape igneous and sedimentary rocks. Examples include: marble, mica, schist, quartzite, slate, and soapstone.



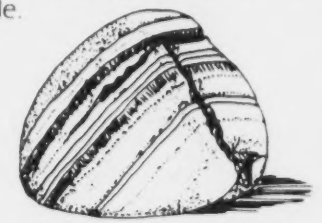
Name of Rock:

Description:
(see list on bottom of page for help)

Draw your rock here

SEDIMENTARY

Sedimentary rocks are formed when particles of sand, soil and mud are pressed into layers on the bottoms of lakes or oceans. Examples include: chalk, flint, limestone, sandstone and shale.



Name of Rock:

Description:
(see list on bottom of page for help)

Draw your rock here

IGNEOUS

Igneous rocks are formed when molten rock wells up to the surface through the crust, cools, and becomes solid. Some magma cools slowly underground, forming crystals that can be seen in rocks (e.g, basalt). Examples include: granite, obsidian, and pumice.

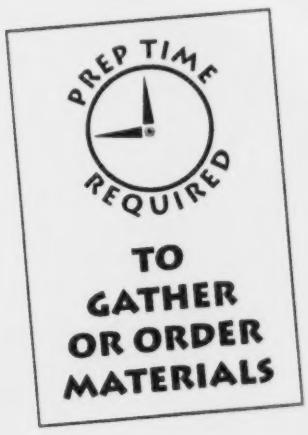
Stuck on words to describe your rock? Try these, or create your own!
My rock is: shiny; sparkling; dull; sharp-edged; hard; big; heavy; soft; little; rough; smooth; colorful; smelly; crumbly; flaky; brittle; powdery; striped; salty; scratchy; knobby; cracked; greasy; squeaky; spotted, scratched, fossilized.

TURNING ROCKS INTO SOIL

ACTIVITY

MATERIALS

- Copies of Activity Sheet 1.3
- Hammer
- Cloth
- Rocks of assorted color, size, and hardness (order from NASCO, see previous pages)
- Safety glasses
- Large balloon
- Small stack of lightweight books
- Medium grade sandpaper
- White paper
- Carbonic acid with eye dropper (available at pharmacies)
- Limestone
- Sand
- Paper plate or pan
- Cup of tap water



Now that the group is familiar with the three different types of rock, explore how rocks turn to soil. Distribute copies of Activity Sheet 1.3. Have group members explore for themselves how soil is formed by completing the sheets. Follow up by performing the following soil formation activities. You may wish to divide the group into teams and assign each one a demonstration, except for the first one, which you should do.

WARNING:

The person performing the demonstration must wear safety glasses. All others must stand back at a safe distance.

1. Wearing safety glasses, wrap several small rocks in a sturdy piece of cloth and hit with a hammer. Show group members how rocks look after repeated blows. Have them guess what force in nature, if any, could cause this much change in so short a period. What natural event(s) would be able to force rocks to break? (Hurricanes, earthquakes, severe freezing, and other violent forces could conceivably split some types of rocks.)
2. Place a large balloon between two light books. As you attempt to inflate the balloon, observe what happens to the books. This illustrates how plant roots grow and split rocks over time, and how water breaks rocks as it expands into ice.
3. Briskly rub the surface of a soft rock with a piece of medium grade sandpaper over white paper. See how much of the rock rubs off onto the paper. This illustrates the influence of sandy winds on rock.
4. Grind two sedimentary rocks together over a piece of white paper. See how much of either rock falls off onto the paper. This illustrates the abrasive force of glaciers.
5. Place a few drops of carbonic acid on a piece of limestone. This demonstrates the (natural) chemical breaking down of rocks. Carbonic acid is formed when carbon dioxide in water reacts with a base (limestone). This is how limestone rock is dissolved away to form caves!
6. Cover the bottom of a pan or paper plate with sand. From about six feet above the pan, drop water onto the surface of sand. This shows how water erodes soil and rock over time (e.g., the banks of a river).

Bringing It Home

To help participants better understand how rocks are turned into soil and the time it takes, discuss the formation of the Grand Canyon. Gather any pictures you have of this area. The Grand Canyon was formed by the Colorado River, which carries an average of 400,000 tons of silt per day (the equivalent of a dump truck full of sand every second!). Ask participants how long they think it took for the river to carve the canyon 5,700 feet deep. (Eons!) What type of weathering occurred? Is weathering still going on?

Guiding Questions

Q Where did the soil under you right now come from? (It may have been brought in by glaciers, sedimentation, volcanoes, or heavy equipment.)

Q Why do some soils have more rocks than others? (Such soils may be the result of glacial deposits, river deposition, or recent volcanic action—especially in Hawaii.)

Q Why do some parts of the world have less topsoil than others? (Possibly because of erosion from wind or water, overcultivation, or even recent lava flows. Also, the area might be young geologically.)

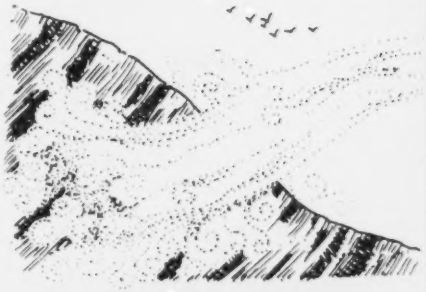
TURNING ROCKS INTO SOIL ACTIVITY SHEET 1.3

Rocks to Soil

Soils are created by the breaking down of rocks into small particles. This process is called weathering. Using the illustration below, draw a line from each description to the picture that shows it.

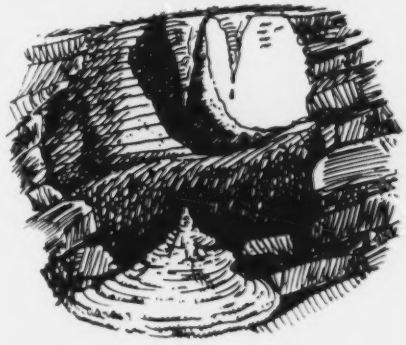
WIND
blows sand against rock and wears it away

RUNNING WATER
wears down rock with the help of sand and gravel



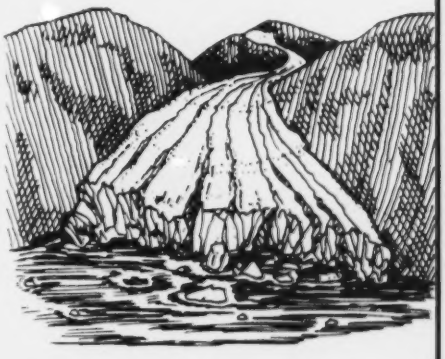
WATER
splits and chips rocks by freezing and expanding in cracks

CONTRACTION
by warm rocks in the cool of night breaks rocks apart



GLACIERS
help to make soil by grinding and breaking loose rocks

ROOTS
of plants force open cracks in rocks



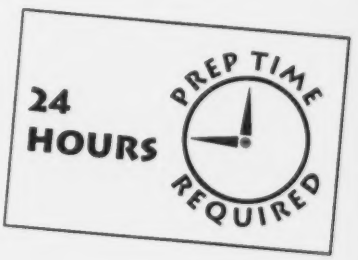
RAINWATER
seeping into soil turns into a natural acid that eats away at limestone to form caves

DIGGING DEEPER

SOIL PARTICLES

MATERIALS

- Two clear one-quart jars with lids
- Two cups topsoil
- Water
- Alum—available at grocery stores
- Teaspoon measurer



Help group members understand that soils consist of various-sized particles by filling a clear jar one third of the way with soil, then adding water and one-half teaspoon of alum (helps the soil settle faster) until the jar is full. Make sure the jar is tightly sealed. Let a few group members vigorously shake it for about three minutes. Once shaken, let it settle. During this time ask participants what they think will happen to the soil in the jar.

Show the group a similar jar with soil and water that you shook the day before. Point out the layers and the soil still in suspension. Ask participants why they think there are different layers in the jar. What are the different layers made of? Why is the water still cloudy?

What to expect: Most natural soils contain various sizes of particles. The largest, heaviest particles, such as sand and pebbles, will settle out immediately to form on the bottom layer. Smaller silt particles will form the second layer. The extremely fine particles (clay) will take a long time to settle, and some clay particles will remain in suspension for some time, making the water appear muddy.

DIGGING DEEPER

TINY ROCKS

MATERIALS

- Hand lenses or microscope
- Sand or sandpaper

Using a microscope or hand lenses, let the group see what sand looks like close up. It's fun to see how many different rock and mineral particles make up sand.

The most common mineral found in sand is quartz. Quartz sand is used to make chemicals, glass, and sandpaper. Some river sands, known as placers (say "plassers"), are rich in mineral deposits. The California pioneers took millions of dollars worth of gold from placers. Pacific island sand consists of grains of basalt, a black igneous rock. Other ocean beach sands may contain tiny particles of coral and clam and snail shells.

SALTY SEAS

ACTIVITY

MATERIALS

- Paper cups
- Warm water
- Salt
- Measuring spoons
- Stir sticks
- Measuring cup
- Fruit juice

Ask the group to volunteer ideas as to why oceans are so salty. The reason is that salt actually is dissolved minerals. The minerals leached from rocks on land over millions of years. First the rocks were broken and ground into soil by ice, wind, and rain. Then rivers carried the salts and soil to the ocean. Since salt doesn't evaporate, it increased in concentration as time went by.

To taste water as salty as the ocean, have each group member place six ounces of warm tap water in a paper cup, then add one teaspoon of salt and stir. Let each one taste the salty water.

Be sure to serve fruit juice afterward to counteract the salty taste!

Bringing It Home

Remind participants that ocean water is not exactly like the solution they just made. Real ocean water contains other types of salts besides table salt, along with elements such as gold and iron.

Guiding Questions

Q Where does the example of salt water fit into the mineral cycle (Activity Sheet 1.1)? (As mineral deposits.)

Q Could salt water be considered a form of natural contamination? (Yes.)

Q Do other elements exist in water? (Yes, iron and sulfur are common in some ground water.)

Q How could you extract salt from ocean water? (By boiling the water—the salt will not evaporate. Many ancient people evaporated salty water in pans or stones set in the sun to extract the mineral for use in food or food preservation.)

2

SOIL BOOSTERS

SOIL'S ORGANIC COMPONENTS

KEY CONCEPTS

- Only a thin layer of the earth's surface contains organic material.
- Organic material is an important component of topsoil.
- Organic content of topsoil can vary from location to location.

Background

We have seen that soil is a fragile layer of loose material that covers most of the world's land. It varies in depth from a few inches to hundreds of feet. Soil is made up mostly of weathered rocks and minerals. It also contains water, air, and decomposing organic matter.

How soil develops depends on five main factors: the underlying rock or sediment, organic activity, climate, time, and the lay of the land. The process of creating soil begins when rocks are exposed to weather. They slowly crumble to form a thin veneer of loose material called the *regolith*. Then the regolith is colonized by plants and animals. Dead animal and plant remains accumulate and mix with the crumbling rock to make soil.

The organic and living content of soil affects it in a number of ways. Living plants encourage infiltration of water. Animals burrow through the soil, also making it easier for air and water to get in. Bacteria, fungi, and animals such as earthworms break down animals and plants, releasing nutrients in a process called *decomposition*. *Humus*—organic matter mixed with inorganic soils particles—adds valuable texture to the soil.

The amount of organic matter present in soil is normally described as a percentage of the oven-dry weight of the soil. It is determined by burning out the organic matter in a furnace. Most soils contain between 1 and 6 percent organic matter. This represents 10 to 60 tons of organic matter in an acre of land with an average eight-inch layer of topsoil.

Discuss With the Group

Explain that nonliving mineral particles make up only a part of soil. The other important component is organic matter, which includes dead plant and animal materials. When the remains of plants and animals decompose they form humus. Dark, crumbly, and spongy, humus typically provides most nutrients used by plants (assuming no fertilizer is used). Humus helps retain soil moisture and provides good aeration, drainage, and a loose, crumbly structure in which plants can grow.

WORDS TO KNOW

Acidic
Alkaline
Decomposition
Respiration
Humus
Microorganisms
Regolith

WHAT'S ORGANIC MATERIAL?

ACTIVITY

MATERIALS

- Poster paper or flip chart
- Markers
- Masking tape
- Box filled with organic materials found in soil (e.g., roots, partially decomposed leaves and sticks, bits of bark, dead beetles and other insects)
- Box filled with mixed organic and inorganic materials (rocks, minerals)
- Napkins (optional)

Seat group members in a circle. Pass around the box of organic materials, and let everyone choose an item (participants may wish to hold their samples with napkins). Ask each person to think about the traits of the item he/she has. Together, develop a definition of *organic materials*. Write ideas on poster or flip chart paper and tape it to the wall. You may want to record ideas as a "burst." Write the term *organic* in the middle, and write their ideas surrounding the term.

After group members have defined organic material, pass around the box of organic and inorganic items. Ask each member to remove something organic. Did they choose correctly?

Help the group understand that organic materials found in topsoil represent plant and animal materials, animal manure, and the decomposed remains of formerly living things.

ACTIVITY

SOIL STUFF

Before you begin, set up a station for each team with jars, soil samples, vinegar, baking soda, and measurers. Bring two quarts of distilled water to a boil. Add a chopped purple cabbage, then remove the water from the heat and let it stand for about 30 minutes, stirring occasionally. Strain the liquid into a pitcher. Give each station a glassful of the liquid.

Explain that the amount of humus is crucial to soil quality and health. Humus is food for *microorganisms* (living things too small to be seen with the eye) that make vital chemical changes in the soil. It also helps bind mineral grains into larger crumbs. Crumbs help soil drain well without drying out and keep minerals available as food for plants.

Soils that are rich in humus tend to be more *acidic* than others. This is because decomposition and *respiration* (the process of breaking down food) of soil creatures makes carbon dioxide, which forms an acid when dissolved in water.

Explain to participants that they will test the acid content of various soils. Divide the group into teams of three or four. Hand out copies of Activity Sheet 2.2, to each team. Review instructions from the activity sheet, then let teams begin working at the stations. Visit each station and help as needed.

After teams have finished the experiment, line up all of the soil samples in order of most acidic to least acidic (*alkaline*). Presumably, the alkaline soils have low organic content. However, some soils will test high for acid even through they do not contain much organic matter.

Guiding Questions

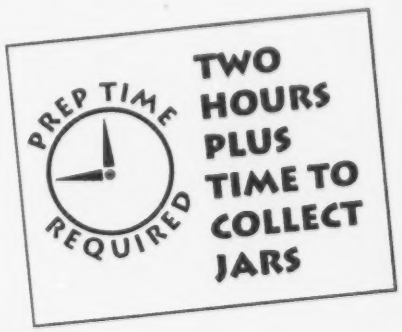
Q If a soil tests acidic, does it have high or low organic content? (Usually high organic content, but not always. Sand, for example, may be acidic but contain low amounts of organic materials.)

Q Why would the organic content of soil from a forest floor differ from a plowed field? (There generally is more organic matter in a forest than in a plowed field. A forest canopy will continually drop leaves, sticks, and other debris, whereas a plowed field has no canopy. However, some agricultural fields can be rich in added material, and some forests, such as those containing cedar trees, can be low in organic material.)

Q Would all plants grow well in highly organic soil? (No. For example, desert plants grow best in low organic conditions.)

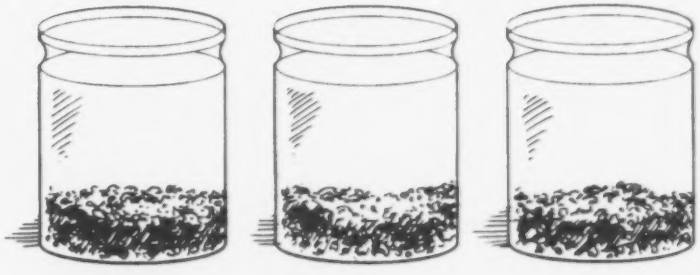
MATERIALS

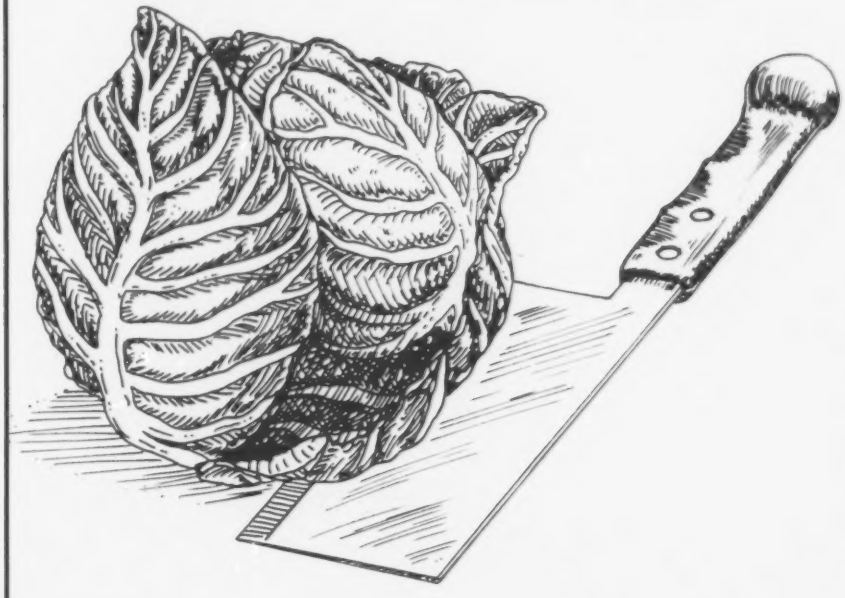
- Copies of Activity Sheet 2.2
- Purple cabbage
- Distilled water
- Pitcher
- Knife and chopping board
- Saucepan
- Strainer
- 12-ounce paper cups
- Five baby-food-sized jars for each team
- Three large soil samples with varying amounts of organic content (e.g., soil from an exposed area, from underneath a bush or tree, and from a wetland or bog)
- Vinegar for each team
  Baking soda for each team
- 1/4 cup measures for each team
- Teaspoons for each team



The Acid Test

The following demonstration is a fun way of comparing the organic content of soils!



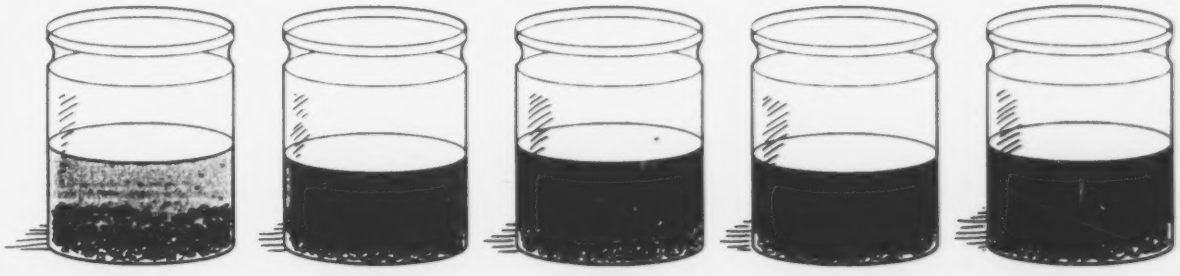


1. Place a different soil sample in each of three jars. Fill each about one-fourth of the way with soil.

2. Fill each jar halfway with cabbage water. The redder the water gets, the more acid the soil is! This usually means the soil is high in organic content. The more blue the water, the more alkaline the soil. This usually means the soil is low in organic content.

3. Fill the two remaining jars halfway with cabbage water. Add about one-fourth of a cup of vinegar to one, and six teaspoons of baking soda to the other. The jar containing the vinegar will be red, indicating extreme acid conditions. The jar containing the baking soda will be blue, indicating extreme alkaline conditions. These jars can be used to compare the acidity and alkalinity of your soils.

4. Line up the jars from blue to purple to red.



ACTIVITY

DIGGING FOR ANSWERS

Take group members to a wooded lot or field where the soil has not been tilled for several years. Break participants into teams of three to four. Help each team collect a soil sample from the area. Dig down about one foot, trying not to disturb the layers of soil as you remove them. Lay the samples on sheets of newspaper.

Have teams slowly break down the layers and examine their soil samples for evidence of organic matter, rocks, minerals and animal life. They should pay particular attention to the amount of organic matter in the soil and its depth. Team members should smell and feel their soil for distinctive characteristics. Also have them write down the types and numbers of living creatures they find.

FIELD TRIP

After the samples have been examined and compared, let each team use a funnel to fill a clear plastic two-liter bottle one-quarter of the way with topsoil. (Be sure they remove any live creatures first.) Have each add about a teaspoon of alum to the bottle, fill it with water, seal and shake it vigorously, then set it on a flat surface and let the materials settle for at least one minute. The soil should settle out into layers with the organic matter at the top. (The alum helps the layers settle more quickly.)

Have teams compare their containers. How different are the cross sections of soils from other areas of the same study site? You may wish to have a similar container filled with highly organic soil and one with no organic content for comparison.

Before you leave the area make sure that any holes are filled in and original organic matter is left where it was found.

Bringing It Home

Have the group think about how the soil was formed. Pay particular attention to the surroundings and the type of plants growing in the soil.

Guiding Questions

Q Do the living creatures in the soil contribute to the organic composition of the soil? (Yes! Many break down the organic matter into nutrients. They also die and become degrading organic material themselves.)

Q Would a leaf sitting on a counter decompose more slowly than one buried in soil? (Yes, because the counter lacks conditions needed for decomposition, including microorganisms and other creatures.)

BIO-NOTE

For a small fee, your county extension office will provide a complete analysis of a soil sample, including organic matter.

MATERIALS

- Shovels
- Paper
- Pencils
- Clipboards (optional)
- Newspaper
- Alum—available at grocery stores
- Clear plastic two-liter bottles with caps
- Teaspoons
- Waters
- Large funnels

DID YOU KNOW?

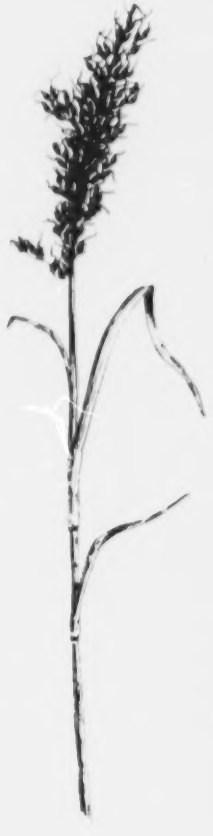
Mature soils have four horizons, or layers. The A horizon is the uppermost layer and contains organic material. The B horizon is strongly leached—most soluble chemicals have passed through this area. The A and B horizons make up topsoil. The C horizon is the subsoil, a layer of weathered and shattered rock. The D horizon is the bedrock. The decomposing matter atop the A horizon is referred to as the O layer (sometimes referred to as a horizon).

DIGGING DEEPER

MATERIALS

- Grass seed
- Two plastic pots
- Low organic soil (e.g., sand)
- High organic soil (e.g., from under shrubs)

About 10 days before the previous activity, take grass seed and plant it in two pots, one containing low organic soil and a one with highly organic soil. The soil should be from the sites you intend to visit on your field trip. Keep soil moist and well lit. The grass seed in the highly organic soil should grow faster than the seed in the other soil. This activity demonstrates the benefits of organic materials in the soil.



3

DON'T EAT THOSE MUD PIES

SOIL'S LIVING COMPONENTS

Background

Topsoil with high organic matter is good habitat for microorganisms and other soil life. Much topsoil consists of living, dead, and decomposing organic materials. The rest of the organic portion consists of plant and animal residues that have been decomposed by microorganisms, earthworms, and insects. Without bacteria and other soil life, these residues (leaves, grasses, fruits, and other organic materials) would never decompose. These living composters recycle the vital elements needed for life.

The various living organisms work in different ways in topsoil. Each plays a particular role in the decomposition of plant and animal matter. Microorganisms such as bacteria and fungi feed on organic matter and humus, breaking down the complex organic molecules and cell walls into basic components that can be used again. *Macroconsumers*—larger creatures such as termites, earthworms, ants, and burrowing rodents—stir up the soil, mixing organic material from the upper layers with minerals from below. Earthworms are especially important, for they take soil in, pass it through their digestive system, and excrete it in worm *castings*. They not only mix the soil, they also change its texture and chemical nature.

KEY CONCEPTS

- Topsoil contains living creatures in addition to rocks, minerals, and organic material.
- Soil organisms vary in size from the microscopic to clearly visible.
- Soil organisms are adapted to live in the soil.
- Soil organisms contribute to soil fertility and productivity.

Discuss With the Group

Explain that bacteria, fungi, funguslike bacteria, earthworms, and insects feed on the remains of plants and animals. These creatures are called *decomposers*. The released nutrients eventually mix with moisture in the soil and are taken up by the roots of plants.

BIO-NOTE

More creatures and organisms live in soil than in almost any other habitat on earth. Some soil scientists estimate that there are billions of bacteria in an ounce of soil!

Explain to group members that they will begin by exploring bacteria—one-celled, microscopic organisms present in almost all natural environments, often in extremely large numbers. There can be several billion bacteria in an ounce of rich garden soil. Bacteria are among the smallest living organisms known. The period at the end of this sentence would cover about 250,000 average-sized bacteria. Bacteria are the most important of the decomposers. Some supply plants with nitrogen; others release carbon.

WORDS TO KNOW

Castings

Composting

Decomposers

Macroconsumers

Soil amendment

BACTERIA AT WORK

ACTIVITY

MATERIALS

- Four clay one-quart pots
- Potato
- Topsoil

About two weeks before the lesson, label four clay pots with the numbers 1 through 4 and fill them with rich topsoil (e.g., from under a shrub or in a forest). Place Pot #1 in an oven and heat it to 400°F for 30 minutes to kill bacteria and other decomposers in the soil. Next, cut four one-inch cubes of raw potato. Bury a cube in each pot two inches below the surface of the soil. Place Pots #1 and #2 side by side in a location away from a window. Pot #2 should never be watered. Put Pot #3 in the refrigerator and Pot #4 in a sunny window. Do not disturb the experiment during this period, except to occasionally moisten the soil of Pots #1, #3, and #4.

The table below summarizes the preparation:

Pot	*Heated?*	*Location*	*Water?*
Pot #1	Yes	Sunny Window	Yes
Pot #2	No	Sunny Window	No
Pot #3	No	Refrigerator	Yes
Pot #4	No	Sunny Window	Yes

Begin the session by describing what you did to each pot. Then carefully remove the soil from each potato. Have the group examine each piece. Determine which piece decayed the most, which types of decomposers were at work on the potato, and what conditions are best for decomposition.

Bringing It Home

Have participants think about places where they've seen decomposition taking place. Consider the rate of decomposition. For example, if they saw a tree decomposing in a forest, was the entire tree decomposing at the same rate, or were different parts decomposing at varying rates? Were the parts in contact with the soil decomposing more quickly?

Guiding Questions

Q Why is decomposition such a relatively slow process? (Many organic processes take time. Decomposition rates also depend upon the material and the environmental conditions.)

Q Are there ways to speed up decomposition? (Yes, you can make conditions more favorable for the decomposers by breaking the item into smaller particles, providing warmer temperatures or moisture, etc.)

Q How could you slow or stop decomposition? (You might regulate the amount of moisture in the system or kill off soil organisms using heat. You also could use refrigeration or colder temperatures.)

ACTIVITY

EFFECTS OF FUNGI ON DECOMPOSITION

Use this activity to introduce the fact that fungi, including yeast used in making bread, are natural decomposers. Fungi are everywhere, particularly where organic matter is plentiful. There are about a million fungi in an ounce of rich topsoil. Together with bacteria, fungi decompose organic matter and release the essential elements that otherwise might be forever locked up in dead plants and animals.

About seven days before this session cut two round slices of uniform thickness from a banana. Place each slice into a separate plastic bag. Sprinkle one-half teaspoon of yeast on one banana slice, then seal the bags, labeling the bag that contains the yeast. Place both bags in a warm, dark place. In the session, show participants the two bags and describe what you did to them. After seven days, the slice with the yeast should show the fastest decomposition.

MATERIALS

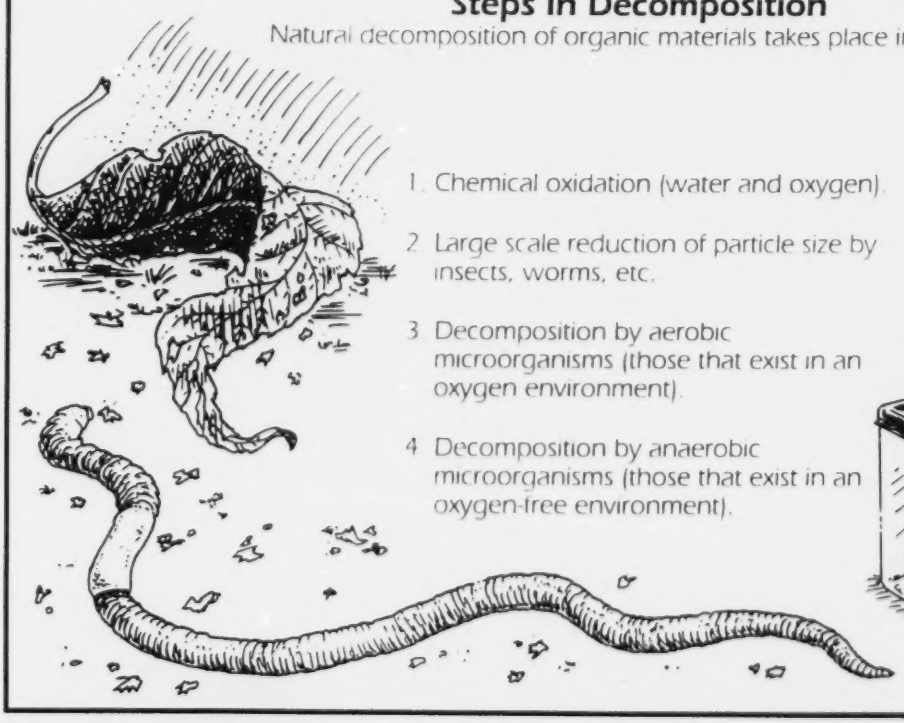
- Banana
- Yeast
- Two plastic sandwich bags

DID YOU KNOW?

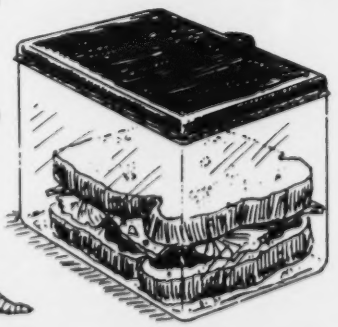
Fungi include mushrooms, brackets, puffballs, truffles, molds, and yeasts. The mushrooms or toadstools we usually see are actually the fruiting, or reproductive, structures of the fungi. These fruiting bodies are not the main part of the fungus, however.

Steps in Decomposition

Natural decomposition of organic materials takes place in 4 steps:



1. Chemical oxidation (water and oxygen).
2. Large scale reduction of particle size by insects, worms, etc.
3. Decomposition by aerobic microorganisms (those that exist in an oxygen environment).
4. Decomposition by anaerobic microorganisms (those that exist in an oxygen-free environment).



Bringing It Home

Explain that yeast is one of 100,000 different kinds of organisms that make up the fungi group. Since they cannot change sunlight into food, they depend on other organisms for food. The yeast feeds on the banana, causing it to decompose.

Guiding Questions

Q How are fungi different from bacteria? (They belong to different kingdoms—scientific classifications. They also differ by size, shape, and what they feed upon.)

Q Do fungi decompose materials rapidly? (It depends upon the environmental conditions and the material being decomposed. Decomposition often takes a long time.)

Q Under what conditions are fungi best suited for decomposition? (Fungi can handle just about any condition—wet or dry, warm or cool. Fungi prosper in acidic conditions and are good at decomposing woody things. Most require oxygen for decomposition.)

DIGGING DEEPER

MICRO MONSTERS

You may wish to discuss funguslike bacteria known as actinomycetes (ak-tin-o-my-seats). These microorganisms share characteristics with both bacteria and fungi. Actinomycetes start to break down organic matter in the later stages of decay. There are 10 to 20 million actinomycetes in an ounce of soil. Many actinomycetes excrete vitamins, growth substances, and antibiotics. Have a sample of freshly dug topsoil on hand for group members to smell. The characteristic earthy odor is due to the presence of actinomycetes.

MATERIALS

- Freshly dug topsoil

BIO-NOTE

The longest earthworm in the world measured 22 feet and was found in South Africa.

BIO-NOTE

Earthworms come out at night, but they disappear if you go close to them with a flashlight. Try covering your light with red cellophane—worms can't see red light. Walk softly, too. Worms feel vibrations and will retreat into their burrows.

EARTHWORM OBSERVATIONS

ACTIVITY

MATERIALS

- Soil samples containing live earthworms
- Newspaper

Introduce another major type of soil decomposers with a discussion of worms. Redworms and earthworms are known for their ability to condition soil. They aerate the soil with tunnels, providing growing plant roots with access to air and nutrients. Worms also pull leaves and organic materials below the surface, digesting and mixing them with the soil. Subsoil minerals are brought up and mixed with the surface layers of the soil. Worms release nutrients from mineral-rich soil and organic matter in the form of castings, making them available to plants. A worm can produce its weight in castings every 24 hours, up to one-half pound each year.

Use this activity to explore the existence of earthworms in soil and their unique contributions. Take soil samples from undisturbed areas where organic matter and earthworms are plentiful. Bring the samples indoors and set them on sheets of newspaper. Try to keep one of the samples intact so the group can make observe it (make sure it's full of earthworms!).

Divide participants into teams of two and assign each a clump of soil. Let each team examine its clump for earthworms. If teams do not find any, have them look for earthworm evidence such as burrows or castings, small pellet-like piles that emerge after organic matter travels through the worm's digestive track. Castings are easily seen on the surface of lawns. They are a valuable *soil amendment*.

When you finish, put soil and worms back into the ground.

Bringing It Home

Explain that earthworms are found in great numbers on grasslands and chalky soil, with fewer in dry land that has been farmed and only a few in dry or waterlogged soil. They feed mainly on decaying plant materials. As they tunnel through the earth, sometimes down to 20 feet, they digest the pieces of humus and pass the remains as castings.

You also may want to discuss some of the scurrying decomposers such as sowbugs, millipedes, termites, beetles, and earwigs. These organisms also break down organic material into nutrients, returning them to the soil.

Guiding Questions

Q How would gardens, forests, and lawns be different without earthworms? (There would be less soil amendment, shorter roots, less mixing of topsoil with subsoil, and more debris on top of the soil.)

Q How do burrowing earthworms help plant roots? (They give roots access to air and moisture and make the soil easier to penetrate.)

Q With so many types of decomposers in the soil, could plants survive without the help of earthworms? (Possibly, for a time. This would be a great question to explore as a science fair activity.)

Q How many earthworms live in an average acre of soil? (About 56,800.)

Q Where do earthworms go in the winter? (They hibernate in the soil beneath the frost line.)

MORE ABOUT WORMS

If you'd like to learn more, get a copy of Molly McLaughlin's *Earthworms, Dirt, and Rotten Leaves* from your library. It contains a wealth of information and ideas to extend the learning of group members in this area.

DIGGING DEEPER

MAKE A VERMI-COMPOSTER

Composting is the biological reduction of organic residue to humus. Vermi-composting is the process of composting organic residue with the help of worms. As the worms eat the organic matter, they pass it through their bodies and produce castings. Vermi-composters are ideal for studying the effects of worms in the soil as well as worm behavior.

Hand out copies of Activity Sheet 3.DD2 to participants. Then construct a vermi-composter as a group.

After you make the vermi-composter, explain to the group that your worms will live and breed in this mixture for a long time. However, they will do better and get fatter if you feed them. Sprinkle a thin layer of cornmeal on top of the soil and scratch it in lightly. The worms also will eat green leafy vegetables, grass cuttings, potato peelings, a small amount of coffee grounds, and almost any other small amount of fruit and vegetable matter. Do not feed them too much; start with just a little, and if they eat it all within a few days you can increase the amount slightly. Never let the soil dry out, but don't keep it soaking wet. Use a plant mister to dampen the soil daily.

After a month or two, it's time to check for new worms. Dump out all the bedding and remove the large worms, which you can use to start another vermi-composter. The bedding with the cocoons and tiny white baby worms can be put back in the original box, where they will have room to grow and develop.

After two or three months, the bedding and castings will begin to look like rich soil. Since the castings create an unhealthy environment for earthworms, remove them from the container and use them around plants as fertilizer. To recharge your vermi-composter, add additional organic matter.

MATERIALS

- Copies of Activity Sheet 3.DD2
- Plastic or wooden container, 15" x 12" x 7"
- Scissors
- Sand
- Topsoil
- Organic residue, such as potato peelings, grass clippings, etc.
- Redworms

DID YOU KNOW?

- The Latin word for worm is vermi.
- The scientific name for redworms is Eisenia foetida, (i-see-nee-a fo-tee-da). They also are known as red wigglers.

RESOURCES

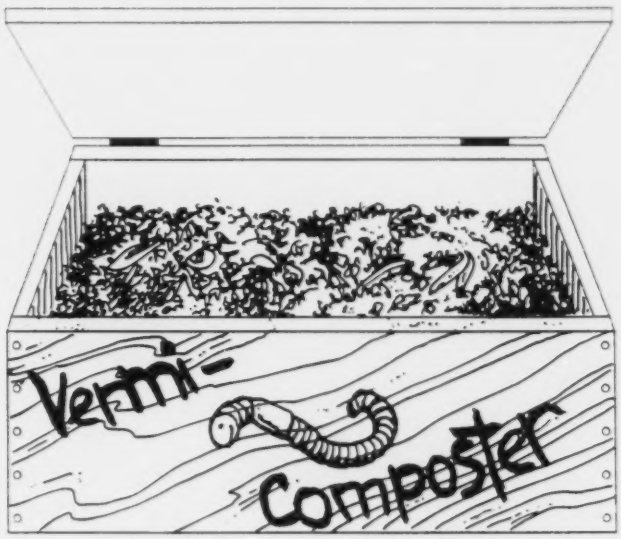
For information and details on worm composting systems, worms, and an activity guide, *Worms Eat Our Garbage: Classroom Activities for a Better Environment* by Mary Applehof, write to: Flower Press, 10332 Shaver Road, Kalamazoo, MI 49002.

Wormania!, a videotape about worms and their role in soil ecology, also is available from Flower Press.

ACTIVITY SHEET 3.DD2 MAKE A VERMI-COMPOSTER

Building a Vermi-composter

To make your own vermi-composter, use a plastic or wooden box 15 inches long by 12 inches wide by about 7 inches high. Make sure the box has a lid. If you use a wooden box, make sure it wasn't made from pressure-treated wood and has never stored chemicals.



1. Drill a few small drainage holes in the bottom and sides of the container.
2. Shred several sheets of newspaper. Fluff these and place in the bottom of the container.
3. Add one or two handfuls of sand and rich soil, and one-half to one cup of water to the bedding. Fluff and stir.
4. Place a layer of well-rotted leaves or other organic residue on top.
5. Place about 300 adult redworms into the container. The worms will dig into the soil within minutes.

REMEMBER TO:

- Feed your worms with light additions of cornmeal once in awhile.
- Occasionally mist lightly.
- Check for baby worms! Move parent worms to another vermi-composter.
- Remove castings periodically, since they can be toxic to worms. Use as a soil amendment.

4

FROM SOIL TO SUPPER

OUR RELIANCE ON SOIL ORGANICS

Background

No plant, person, earthworm, or bacterium can survive alone. We all depend on one another for our existence. Many types of relationships exist, at many levels and degrees of complexity. For instance, many plants depend on animals to pollinate their flowers and/or disperse their seeds. Animals, including humans, depend on plants for food, fuel, and shelter.

Living things in the earth's ecosystem share some basic characteristics. They are all sustained by each other in a delicate balance of life. They also are all organic. This means that the death of one always provides life for another.

Discuss With the Group

Share a copy of Activity Sheet 4.0 with the group. Explain that soil supports the production of organic materials for food, shelter, clothing, and other products. Challenge group members to determine which products in the room originally came from the soil.

"Nature has no interest in the preservation of her dead; her purpose is to start their elements upon the eternal road of life once more." *Loren Eiseley*

KEY CONCEPTS

- A relationship exists between the soil, the creatures that live in it, and the plants that grow there.
- People who consume plants become part of the soil-creature-plant relationship.
- Traces of topsoil and soil nutrients are removed when plants are harvested.
- Topsoil is a limited resource.

WORDS TO KNOW

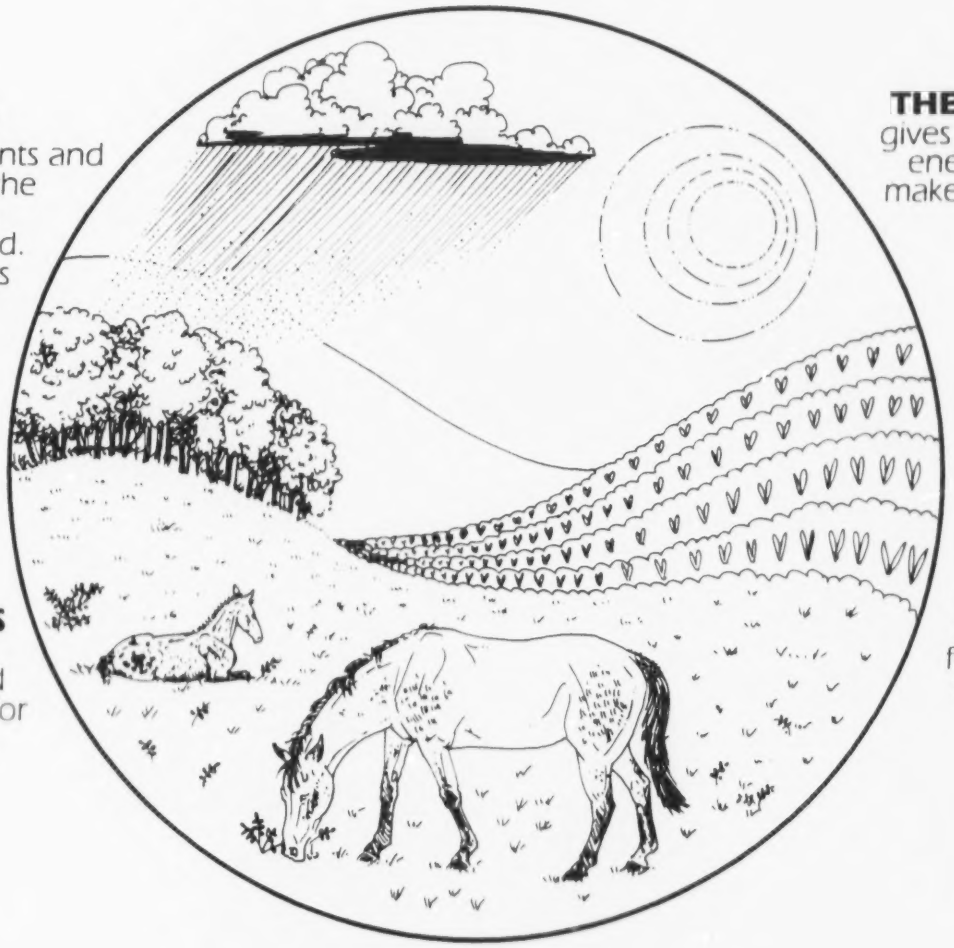
Consumers

Producers

ACTIVITY SHEET 4.0 SOIL ORGANICS LIFE CYCLE

WATER
gives plants and animals the moisture they need. Air carries essential gases.

THE SUN
gives plants energy to make food.



PLANTS
provide food and oxygen for animals.

SOIL
provides minerals for plants to grow.

ANIMALS
eat food and breathe oxygen. Their droppings enrich the soil. When they die, their bodies rot and return nutrients to the soil.

ACTIVITY

TRAVELING TOMATOES

Divide participants into teams of three. Then hold up a bunch of grapes, a tomato, and an apple. Ask what the three fruits have in common (e.g., nutrition, fiber, transported some distance to get here). Assign a fruit to each team. Have team members think about and report:

- Where is the crop now in season?
- How is the soil prepared to produce the crop?
- What does the soil give up to produce the crop?
- Is the crop grown around the world?
- Is the crop shipped to the United States in off seasons?

Each team should assign a discussion leader, a recorder, and a reporter. Allow teams about 15 minutes to discuss the questions and prepare their reports. Have references such as encyclopedias or agricultural texts on hand so teams can research their answers.

MATERIALS

- Grapes
- Tomatoes
- Apples

For more information about agriculture and its role in cycling back to nature, order *Food Production and Pesticides: Cycling Back to Nature*, from National 4-H Council, 7100 Connecticut Avenue, Chevy Chase, MD 20815.

Bringing It Home

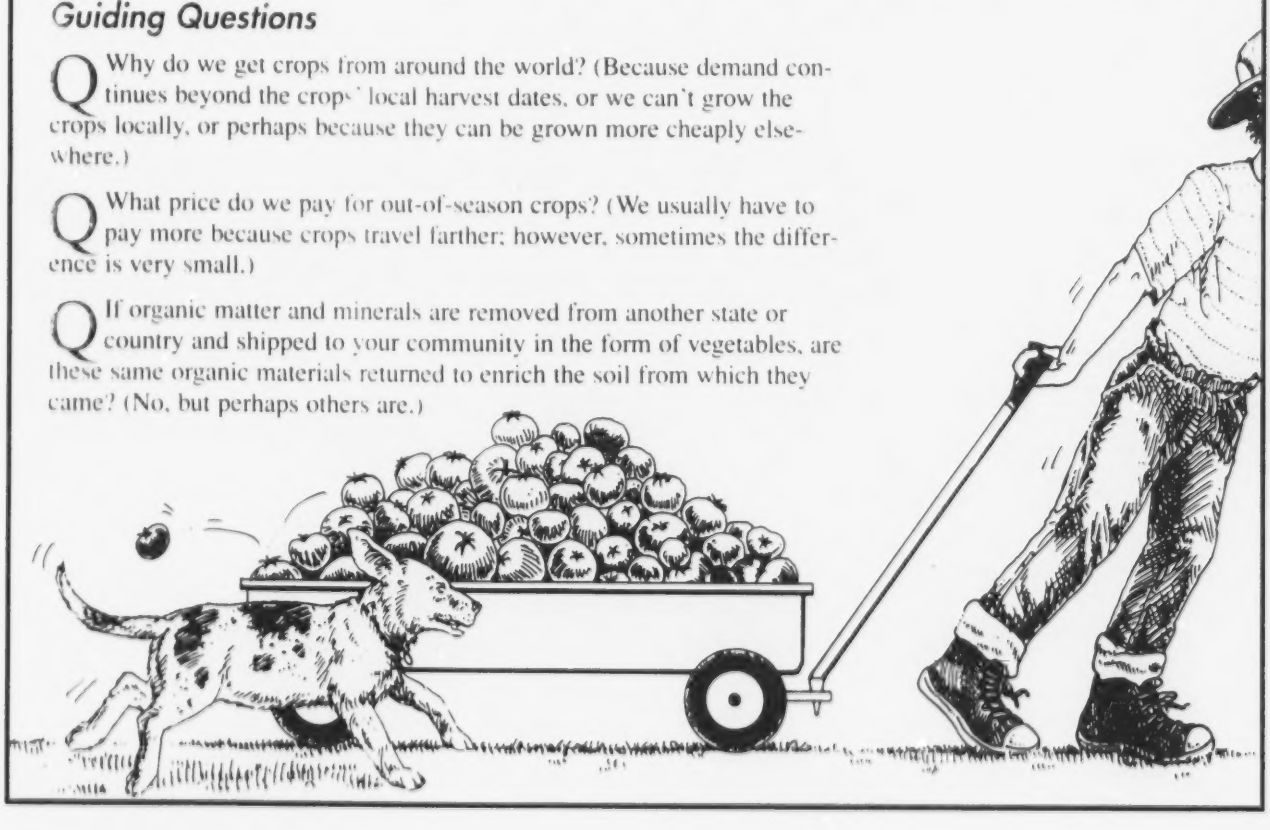
Help group members see the global perspective of fruits and vegetables. For example, go to your local supermarket and ask the produce manager where the fruits and vegetables came from this week. Use a world map to show how far the various crops traveled to get to them.

Guiding Questions

Q Why do we get crops from around the world? (Because demand continues beyond the crops' local harvest dates, or we can't grow the crops locally, or perhaps because they can be grown more cheaply elsewhere.)

Q What price do we pay for out-of-season crops? (We usually have to pay more because crops travel farther; however, sometimes the difference is very small.)

Q If organic matter and minerals are removed from another state or country and shipped to your community in the form of vegetables, are these same organic materials returned to enrich the soil from which they came? (No, but perhaps others are.)



PEANUT FARMING

ACTIVITY

MATERIALS

- Peanuts (in the shell) attached to leaves made from paper
- Play money
- Masking tape to attach peanuts to paper

Divide members into equal teams of Producers, Transporters, Processors, and Consumers. Define their roles as follows:

Producers: People who pick the crop. In nature, *producers* are green plants that make food using carbon dioxide, water, and sunlight.

Transporters: People who move the crop from the field to the factory, or the product to the consumer.

Processors: People who turn the crop into a ready-to-sell product by cleaning, packaging, and otherwise altering it.

Consumers: People who eat the product. In nature, *consumers* are any animals that eat green plants or other animals.

Have Consumers cluster in one corner of the room. In the opposite corner, let Producers scatter unshelled peanuts with leaves attached onto the floor. Position Processors halfway between the two. Transporters should be standing ready at the side of the room. Once the groups are positioned, have them act out what you read:

Here are the Palmer County Peanut Producers. They are harvesting their peanut crop. (Producers remove peanuts from leaves—return leaves to the floor for later discussion.) The peanut is an organic product that grows underground on the roots of peanut plants. Peanuts contain nutrients obtained from the soil and are a good source of protein.

Once Producers harvest their crop it is taken by Transporters to a nearby processing plant. There the peanuts are shelled, roasted, salted, and packaged for consumption. (Have Processors shell peanuts for distribution to the Consumers, but leave the pile of shells on the floor for later discussion.)

From the processing plant, Transporters take the product to market. Consumers purchase the peanuts and consume the product. (Be sure to have some leftover peanuts for later discussion.)

Bringing It Home

Have participants talk about the organic products that were left behind in the process of getting peanuts from the Producer to the Consumer.

Guiding Questions

Q Although the peanuts removed nutrients and minerals from the soil, did leaving the peanut plant behind to decay help the soil? (Yes, but it needs to be properly composted with the soil for best results.)

Q Would it be beneficial for the processing plant to return the peanut shells to the farmers' soil? (From an environmental standpoint, yes. However, the processing plant may not be able to do this economically.)

Q What should the consumers do with their leftover peanuts? (Compost them and return them to the soil as a soil amendment.)

DIGGING DEEPER

ORGANICS IN OUR TOWN

Using the phone book, identify businesses in your community that grow or use organic materials. Have group members categorize them (food processing, food retailing, clothing, manufacturing, construction, etc.). How much of the economy is devoted to agricultural production and processing?

Have group members diagram the many stages an organic product goes through in the community. Follow it step by step through production, delivery, sale, processing, consumption and disposal. For example, you might study how a tree is harvested, cut up for various uses, processed, delivered, sold, used, and eventually reused, recycled, or returned to the environment. Have a guest speaker who works in some stage of the process talk with the group.

Going Beyond

To prepare for the next chapter, have group members think about the organic materials they use in and around their home and community. Also ask them to think about how they dispose of organics. Ask if they believe their leftover organics are disposed of properly, in other words, allowed to return to the soil to decompose and enrich it.

MATERIALS

- Phone book
- Poster paper

CYCLING BACK TO NATURE

. . . WITH ORGANIC RESIDUE

5

KEY CONCEPTS

- The disposal of organic residue in the United States varies from location to location.
- There are benefits and costs to returning organic residue to the soil.
- Composting returns organic residue to the soil.

Background

What do we do with our organic residue (lettuce leaves, newspapers, coffee grounds, etc.)? The answer to this question varies with the type of organic residue. Agricultural (post-harvest) trimmings are left behind to decompose. Organic residue that's flushed or dumped down the drain ends up as *sludge* in municipal water treatment facilities. This is the liquid, semisolid, and solid material left over from sewage treatment. Some may eventually be used to enrich the soil.

However, many organic byproducts—food scraps, wood, spoiled produce, paper, cloth, rubber and yard trimmings—end up in landfills. Landfills are not designed as soil processing sites. Rather, they are designed to keep yard trimmings and other organic materials in and moisture and oxygen out. After examining an old landfill, researchers discovered 50-year-old carrots, steaks, newspapers, hot dogs, and other organic matter in identifiable condition. These items didn't decompose because the needed oxygen and moisture were not present.

According to the Environmental Protection Agency, approximately 45 percent of the discards found in a landfill are organics that could be separated and composted. Half of this compostable material could be composted at home, school, or work. Some communities have both municipal and home compost operations. For example, households are encouraged to divert food scraps and yard trimmings into at-home compost systems. All other organic materials are taken to a community compost facility where they are ground up and placed in a composting area to decompose. Months later, the compost is ready to be returned to the soil as a soil conditioner.

Discuss With the Group

Have participants think about how organic materials are disposed of in their community. Review the types of organic materials that enter the waste stream and how they are returned to the earth. This includes disposal through the use of landfills, sewage treatment plants and municipal compost facilities. Help them see the benefits of composting in their community, schools, and homes.

WORDS TO KNOW

- Aerobic
- Anaerobic
- Sludge

ACTIVITY

ORGANIC LEFTOVERS

Distribute Activity Sheet 5.1. Have participants read it and decide whether the statements are true or false. Review the answers, then ask them to categorize the true items as advantages or disadvantages to composting.

MATERIALS

- Activity Sheet 5.1
- Pencils

43

Test Your Recycling Knowledge

Read the following statements about organic residue recycling, then determine whether they are true or false. (answers below)

T F 1. In general, all cultivated land gradually loses its organic content, a valuable portion of the soil.

T F 2. Sewage treatment plants are one source of organic residue that could be returned to the soil, assuming the residue has been detoxified and sanitized.

T F 3. We can compost aluminum cans and plastic bottles and reduce space needed for landfills.

T F 4. Vegetable food processors and other such companies are a source of organic residue that could be returned to the soil.

T F 5. Yard trimmings placed in plastic lawn or leaf bags rapidly decompose.

T F 6. It is possible to recycle many organic residues. We can spread them on the land to add organic matter to the soil.

T F 7. It may be too expensive to spread organic residue on land that is far away from a source, due to high transportation costs.

T F 8. Hazardous chemicals and heavy metals can contaminate organic residue.

T F 9. Contaminated organic residue creates a health hazard when spread on land.

T F 10. We can test organic residue quality before it is spread on land.

T F 11. We will benefit if we recycle organic residue carefully.

ANSWERS

Number 3 and number 5 are false, all the rest are true

ACTIVITY

HOW COMPOSTING WORKS

MATERIALS

- Copies of Activity Sheet 5.2 (two pages)
- Plastic bag filled with organic residue
- Samples of composted materials in various stages of completion
- Hand lenses

Composting is when humans promote the natural process of decomposition and nutrient cycling by creating an environment in which decomposers thrive. As the decomposers use the organic matter, they break it down into simpler particles that can be used as nutrients by plants, starting the cycle over again.

Composting gives off heat (up to 140°-160°F), accelerating decomposition. While microorganisms accomplish most of the chemical decomposition in a compost pile, small invertebrates such as sowbugs and earthworms are responsible for much of the physical breakdown of materials.

Give participants a copy of Activity Sheet 5.2 (two pages). Explain that composting requires the separation of food scraps and other organic materials from the waste stream so they can degrade naturally into a rich soil amendment. In a well-maintained compost pile, organic materials are piled layer upon layer, then mixed, aerated, and watered, providing the right moisture and temperature for decomposers to survive.

Although we can't actually see many of the decomposers, your group members can explore their behavior. Whether or not you build an outdoor compost pile, you can pique their interest in composting with some exploratory activities.

About two weeks before this activity, fill a plastic bag with organic matter (e.g., cut fruit, grass clippings, moist bread). Leave the bag open on a counter to table to encourage *aerobic* (oxygen- aided) decomposition. Place a sign reading "What do you think is happening in this bag?" near the bag. Encourage participants to observe and explain what they see.

Challenge group members to work outdoors in small teams to identify examples of decomposition in action. Have them describe what they observe. What leads them to think decomposition is occurring? For example, is decomposed organic matter dark and damp? Does it have a strong odor? Explain to the group that much natural decomposition happens aerobically. If there isn't enough oxygen present, than the process is *anaerobic* (without oxygen), and the results are smelly! We try to encourage as much aerobic composting as possible.

Ask participants to suggest uses for composted material. Point out that compost is an excellent soil amendment. It can be worked into garden soil in the spring or placed around shrubs and trees.

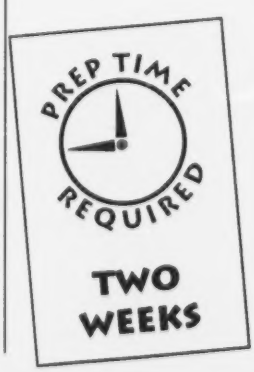
Show group members examples of the various stages of decomposition, including the finished product. Have them smell and feel the examples that you brought. Have several hand lenses available for closer examination.

Bringing It Home

Ask which group members have a compost pile at home. Encourage those who don't to follow the directions on the activity sheet and start one at home or with a friend.

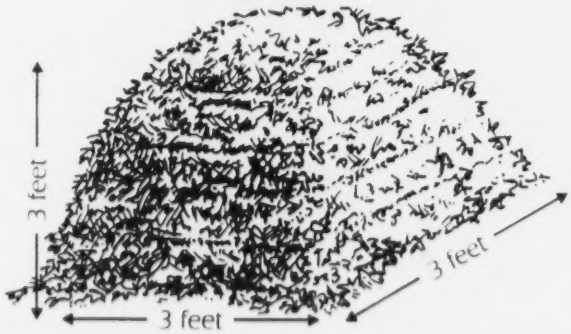
MORE ABOUT COMPOSTING

Contact your county extension office for additional information about composting. The Environmental Hazards Management Institute, 10 New Market Road, Dunham, NH 03824, (603) 868-1496, also has a handy resource, The Home Composting Wheel.



Making a Home Compost Pile

A Compost Pile



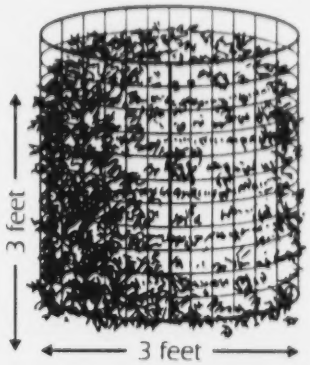
1. Choose a site for your compost pile or bin. Place it on soil that drains well. Minimum size is 3 feet x 3 feet x 3 feet.

2. Layer compostable materials in the pile or bin as shown below. Chop or shred the materials if you want them to break down more quickly.

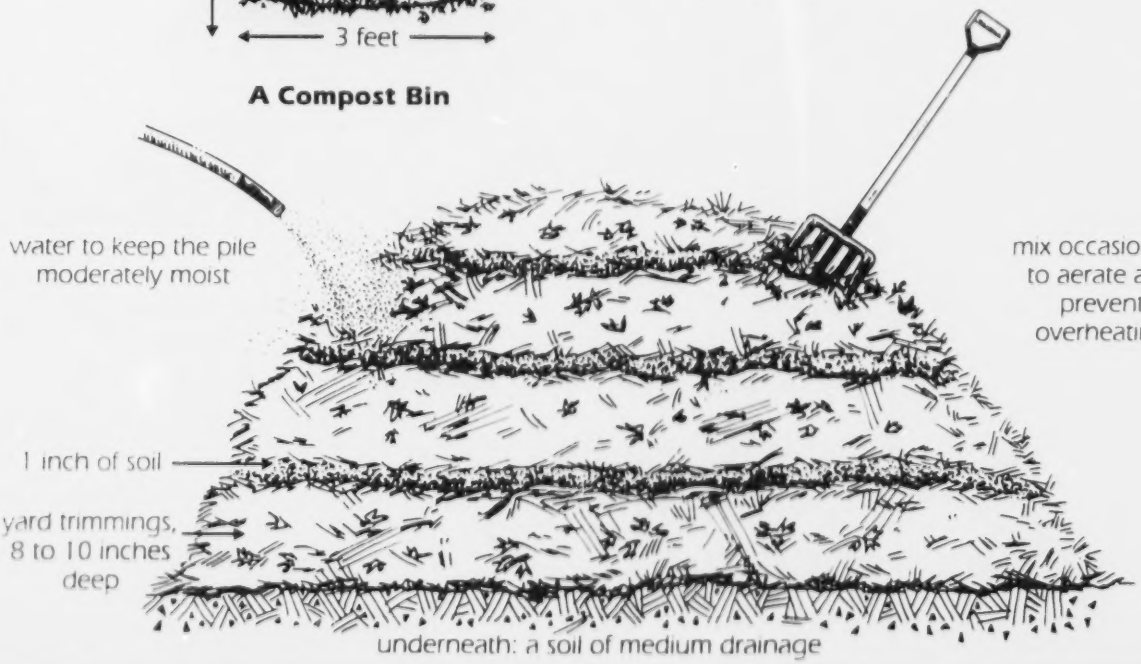
3. Add water as needed. Materials in the pile should be damp to the touch, like a wrung out sponge.

4. If you mix or turn your compost pile weekly, it should be ready to use in one to two months. If you don't turn it, the compost will take six to twelve months and you may have an odor problem.

5. Finished compost should look like dark crumbly soil mixed with small pieces of organic material. It should have a sweet, earthy smell.



A Compost Bin


water to keep the pile moderately moist
mix occasionally to aerate and prevent overheating
1 inch of soil
yard trimmings, 8 to 10 inches deep
underneath: a soil of medium drainage

ACTIVITY SHEET 5.2 RECYCLING ORGANIC RESIDUE

Composting occurs naturally nearly everywhere! Leaves drop from trees. Grass clippings are left after mowing the lawn. Vegetable plants die at the end of the season. Over time, these organic materials decompose. The rich, dark, soil-like material that results is compost.

Tiny living organisms do much of the work of breaking down organic materials to form compost. These tiny workers, called *microorganisms*, include bacteria and fungi. Animals such as worms and sowbugs help microorganisms break down organic materials, too.

Microorganisms and soil animals use organic materials as a source of energy and nutrients for their growth and activity. Eventually, the nutrients are returned to the soil to be used again by plants. This is nature's way of recycling!

WHY COMPOSTING?

With the composting method described below, you can help the decomposition cycle work better and faster. The organic materials you put back into the environment through composting can be used by other living things. Instead of ending up in a landfill, garden trimmings become valuable resources for your garden.

WHAT TO COMPOST?

You can compost any plant material from your garden as well as yard trimmings such as leaves and dead flowers. Grass clippings can be composted but are best left on the lawn, where they return nutrients to the soil directly.

You also can include a few other materials such as sawdust, wood ash, orange peels, coffee grounds, and eggshells. In urban areas, it's best not to add meat or other animal product food scraps to a compost pile, since they will attract rodents and other animals.

To get your compost pile to work best, include a good mix of brown stuff and green stuff. Other items you will *need* to add to your compost pile are air and water.

When composting at home, do not compost:

- Any part of black walnut trees (they release harmful toxins).
- Meat, fish, bones, dairy products, breads, fatty or greasy foods, or salad and cooking oils—these attract rodents and other unwanted pests.
- Dog and cat manure.

DO COMPOST...

Brown Stuff

- dried leaves
- straw
- cornstalks
- sawdust
- wood chips
- shredded paper
- hair
- dryer lint

Green Stuff

- green leaves/plants
- grass clippings
- coffee grounds
- tea bags
- eggshells

Other Stuff

- water
- air

DON'T COMPOST...

- Black walnut tree parts
- Meat, fish, bones, dairy products, breads, fatty or greasy foods or oils
- Dog and cat manure

THE COMPOSTING TREE

ACTIVITY

MATERIALS

- Colored candies
- Envelope of confetti (made by a paper punch)
- Green construction paper cut into leaves
- Orange and red construction paper cut into flames
- Purple and orange construction paper cut into garden vegetables
- Brown face paint
- White paper
- Pens, crayons, or markers
- Masking tape

Ask a group member to stand on a short box and become the "trunk" of a tree. Next select ten group members to become the tree's leaves. As they come up, have them take paper leaves and attach themselves to the tree by placing a hand on him or her. Ask the remaining group members to explain what leaves do for a tree. (They make food, helping the tree survive.) Hand leaves colored candies and ask them to eat them. Tell them they are storing up nutrients for the tree. As they finish their candies, have them pretend fall is approaching. Ask the audience what happens to leaves in the fall. When they say that leaves fall, direct leaves to drop off the tree one by one.

When all the leaves have fallen, ask the rest of the group what can be done with the leaves, which have fallen onto a lawn. Encourage the group to come up with solutions such as mulching the leaves into the soil, leaving them where they are, or creating a compost pile.

Tell participants you would like to start a compost pile. To do this, you need to rake the leaves into a pile. Get one or two volunteers to be the "rakes" and have them herd the leaves into a pile.

Tell the group you are going to use a three-sided compost bin. Get three people to represent the walls of the bin and have them loosely stand on three sides of the pile. When the bin and leaves are in place, ask what it takes to turn leaves into compost. Participants should come up with things such as microbes, worms, insects, moisture, air and heat. As these things are mentioned, do the following:

Explain that microbes naturally exist in the pile. Have a few people quickly draw and place pictures of make-believe microbes in and around the leaves.

Hand someone an envelope of confetti. Explain that it represents moisture. Instruct the person to spread it gently on the leaves. Explain that microbes need moisture to thrive in compost.

Note that the desirable aerobic bacteria require plenty of air. The compost must be at least 50 percent air (by volume) or there will be odor problems. Have someone fan the pile. As they do, instruct the leaves to simulate the turning needed to increase oxygen.

Have a volunteer place some construction paper flames in the pile. Explain that the flames represent heat produced by bacteria when they respire (break down food releasing energy). Remind participants that the internal temperature of compost can reach around 140°F within three or four days. Explain that while high temperatures speed up the process and kill disease organisms and weed seeds, composting still works at lower temperatures. In fact, larger organisms such as worms and insects, don't tolerate heat—they work in the pile at much lower temperatures on the outside layers.

Next, ask if anyone knows what happens to leaves during decomposition. Someone in the group may mention that they disintegrate. Have the leaves depart from the pile one by one. As they depart put brown face paint on

their faces to simulate their new look as compost.

Finally, instruct the new composts to lie on the ground with space in between. They are in the garden bed. Give several new volunteers cutouts of garden vegetables, along with several pieces of candy. They are to carefully kneel between the rows of composts and slowly stand, growing with the help of the compost nutrients. As they grow, they may wander out into the group, handing out the harvest (candies) to the hungry humans.

Bringing it Home

Have participants discuss various uses for compost. Ask them why they think people and communities often are reluctant to compost organic residue. (Fear of attracting rodents, odors, aesthetics, too much work, no place to put it, no requirements to separate organic matter from trash, etc.) Help group members think of some ways to increase the return of organic residue to the soil. Ask what *they* can do *right now* to make things better. Lead them to discover practical ways to use, reuse, reduce, or recycle organic residue. Encourage them to think creatively as well as practically.

MAKE A POINT WITH CLAY

ACTIVITY

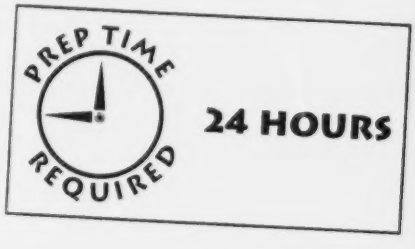
This activity furthers participants' understanding of the improper disposal of organic residue in the community.

MATERIALS

- Cooked play clay
- Plastic bags
- Large container with lid
- Waxed paper
- Rolling pins

Separate the group into producers, consumers, and decomposers. Explain the role of each in nature. (Producers are the green plants that use carbon dioxide, water, and sunlight to make food. Consumers are animals that eat plants or other animals. Decomposers are organisms that break down organic residues.) Give producers a lump of play clay and tell them it represents organic matter. Each producer should form the clay into a tree shape.

When producers have completed their task, have consumers take the clay trees from the producers. They should fashion the trees into toothpicks, then send them to the compost pile, where decomposers are awaiting. The decomposers will take the toothpicks and roll them into marble-sized balls for reuse by the producers. (Save a few toothpicks for the next steps.)



Repeat the cycle, but this time start by having the consumers roll clay into a thin layer by placing it between two pieces of waxed paper and flattening it with a rolling pin. Then, have them wrap the flattened clay around the toothpicks left over from the first cycle.

COOKED PLAY CLAY

Prepare 24 hours ahead, one batch per team of eight

One cup flour

1/2 cup salt

Two teaspoons cream of tartar

One cup water

One tablespoon vegetable oil

Cook in pot over moderate heat until ingredients form a ball. Knead with hands. Store in an airtight container.

Explain that this wrapping is like the biodegradable packaging (made from wood fiber or various starches such as corn) that could be used to contain organic residue being transported to municipal compost facilities. Send the wrapped toothpicks to the decomposers who will then mash them together and return them to the consumers for reuse.

Now place the toothpicks in a container (representing a landfill) and have someone sit on it (representing the earth covering a landfill). Challenge the decomposers to get the toothpicks so they may be returned to nature.

Another option is to have consumers make a wrapping out of a different color of clay representing nonbiodegradable packaging such as aluminum or plastic. Let the consumers cover the toothpicks with this wrapping. Explain that to properly decompose, the toothpick must be removed from the wrapping. Challenge the decomposers to remove the colored clay. If they cannot remove all traces, the consumers must separate the clays (source separation).

After participants observe the benefits of biodegradable containers and composting and the disadvantages of landfills, have them consider similarities in the real world.

Bringing It Home

Help the group see that a combination of education and community initiative is needed to make composting work. Municipalities, for example, need to establish an infrastructure to make it easy, convenient, and safe to compost at home or pick up household organics. It is easy to envision a bio-bin for pickup of household organic materials to assure high-quality input at the composting facility. If your community doesn't offer composting, initiate composting at school or at home. This may already be happening in many communities as landfill bans on yard trimmings spring up across the country.

Guiding Questions

Q How do we slow decomposition of organic products? (Use preservatives, dispose in landfill.)

MAKE A COMMITMENT

ACTIVITY

Explain that it's now the group's turn to share its knowledge of composting. Have participants list things they can do in their homes, schools, or communities to make a difference. At the end of the discussion, have each person list what he or she will do.

One way to spark action is to write a letter to local officials. Letter writing is a good way to communicate concerns about the environment to others. Pass out a copy of the Letter Writing Tip Sheet on the next page. Have group members decide what issues they would like to address and to whom to write. For example, they might write letters to:

- the officials at a plant-material processing plant, asking how they dispose of organic byproducts. Suggest they explore composting.
- local governmental officials, explaining concerns about the lack of proper composting facilities in the community.
- the editor of a local newspaper, expressing a need for greater awareness for community composting. Describe how community leaders might increase community awareness. You may wish to include a photograph of group members doing something to address this issue.

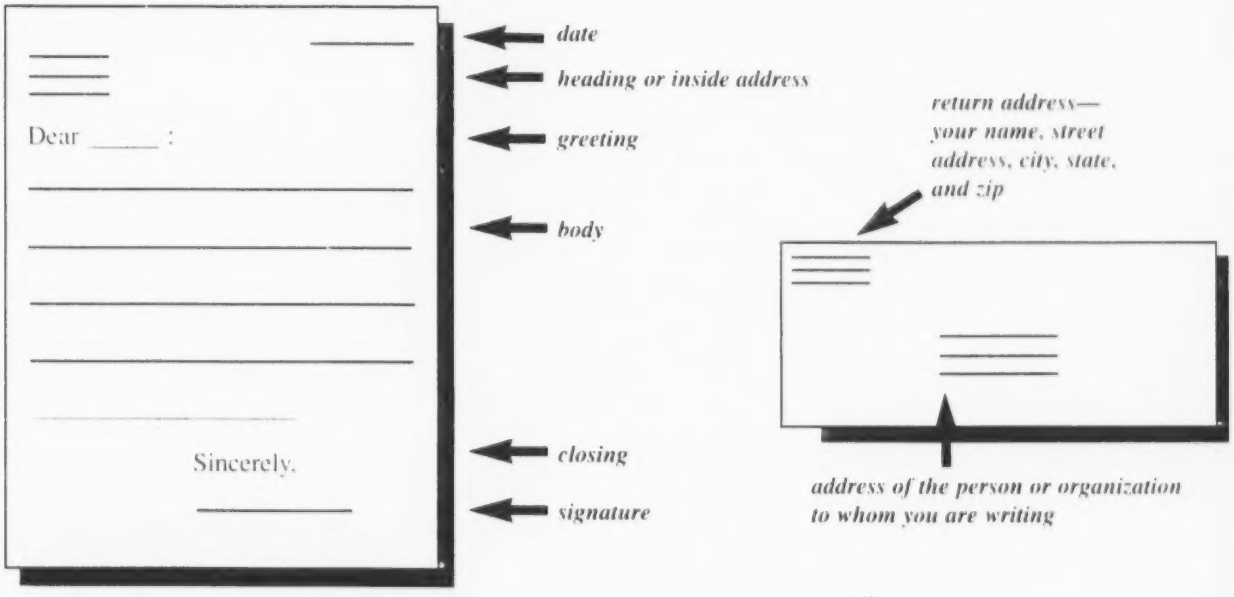
Going Beyond

There are many things your group can do to increase public awareness of composting. Depending on their ages, group members might publish a monthly newsletter of ideas or create informational posters, bumper stickers, or T-shirts. If publishing a monthly newsletter seems too overwhelming, they can ask other newsletters or local newspapers if they could contribute columns about composting.

For additional information or assistance on household or community composting, contact your county extension office.

LETTER WRITING TIP SHEET

This is the correct form for writing and addressing a business letter:



When writing to the president of the United States, address your letter and envelope as follows:

President (Name)
The White House
1600 Pennsylvania Avenue
Washington, DC 20500

When writing to a U.S. senator, address your letter and envelope as follows:

The Honorable (senator's name)
U.S. Senate
Washington, DC 20500

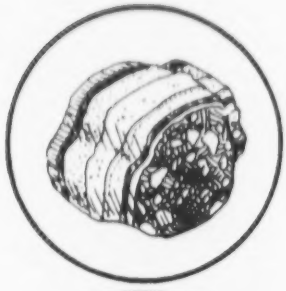
When writing to a member of the U.S. House of Representatives, address your letter and envelope as follows:

The Honorable (member's name)
U.S. House of Representatives
Washington, DC 20500

If you do not know who your United State senators or representatives are, ask your local librarian.

FROM TINY ROCKS TO COMPOSTING

ACTIVITY



Discuss with the group the lessons learned in this curriculum, from tiny rocks to composting. A good way to do this is to review the main concepts from each chapter.

Key Concepts, Chapter One

- Soil consists mostly of inorganic solids such as rocks and minerals.
- Rocks generally are made of two or more minerals, although some, like quartzite (quartz) and marble (calcite) contain only one mineral.
- Minerals, solid uniform chemical elements or compounds made by nature, move in the environment in cycles.

Key Concepts, Chapter Two

- Only a thin layer of the earth's surface contains organic material.
- Organic material is an important component of topsoil.
- Organic content of topsoil can vary from location to location.

Key Concepts, Chapter Three

- Topsoil contains living creatures in addition to rocks, minerals, and organic material.
- Soil organisms vary in size from the microscopic to clearly visible.
- Soil organisms are adapted to live in the soil.
- Soil organisms contribute to soil fertility and productivity.

Key Concepts, Chapter Four

- A relationship exists between the soil, the creatures that live in it, and the plants that grow there.
- People who consume plants become part of the soil-creature-plant relationship.
- Traces of topsoil and soil nutrients are removed when plants are harvested.
- Topsoil is a limited resource.

Key Concepts, Chapter Five

- The disposal of organic residue in the United States varies from location to location.
- There are benefits and costs to returning organic residue to the soil.
- Composting returns organic residue to the soil.

RESOURCES

Allaby, Michael. *Illustrated Dictionary of Science*. Andromeda, England, 1988.

Erickson, John. *An Introduction to Fossils and Minerals: Seeking Clues to the Earth's Past*. Facts on File, 1992.

Horton, Robert, Heimlich, Joseph; and Hollyer, James. *Cycling Back to Nature With Biodegradable Polymers*. Washington, D.C.: National 4-H Council, 1994.

Houston, David. *Understanding the Game of the Environment*. Agriculture Information Bulletin # 46, U.S. Department of Agriculture, Forest Service, 1979.

Kroll, Mary. *Food Production and Pesticides: Cycling Back to Nature*. Washington, D.C.: National 4-H Council, 1995.

Pough, Frederick. *Peterson's First Guide to Rocks and Minerals*. Boston: Houghton Mifflin Company, 1991.

Symes, R.F. *Rocks and Minerals*. Random House, 1988.

Webb, Angela. *Talk about Soil*. F. Watts, 1986.

The Cooperative Extension Service office in your county has access to many publications concerning composting and soil. Visit an area office soon.

GLOSSARY

Acidic: a chemical compound that reacts with a base to form a salt; able to neutralize alkaline materials.

Aerobic: in the presence of oxygen.

Alkaline: able to neutralize acids.

Anaerobic: in the absence of oxygen.

Casting: worm excrement that acts as a soil amendment.

Cleavage: the tendency of a mineral to split along a definite plane parallel to an actual or possible face.

Composting: the process by which organisms degrade organic matter.

Consumer: an organism that eats plants or animals.

Decomposer: any bacterium, fungus, or other organism that chemically degrade or decay organic matter.

Decomposition: the change in chemical composition of organic matter due to the actions of aerobic or anaerobic organisms.

Element: a substance that cannot be separated by chemical means into substances different from itself.

Hardness: a measure of how hard a mineral is in comparison to other objects.

Horizon: a layer of the soil.

Humus: dead plant and animal matter that is partly or entirely decomposed, mixed with inorganic components.

Igneous rock: rock formed when hot liquid rock works its way into the earth's crust, then cools and hardens. Examples include basalt, pumice, obsidian, and granite.

Inorganic: not of plant or animal origin.

Macroconsumer: an organism, mostly animal, that is bigger than bacteria and eats organic matter or other animals.

Metamorphic rock: formerly igneous or sedimentary rock that has been changed into a different kind of rock by extreme heat and pressure. Examples include slate, marble, and quartzite.

Microorganism: any microscopic organism including bacteria, fungi, yeast, some algae, and protozoa.

Mineral: a solid, uniform chemical element or compound made by nature.

Nutrient: an element or compound essential for the growth and development of an organism.

Organic: relating to or derived from living things.

Parent material: rocks, boulders, etc., from which the inorganic part of soils are derived.

Producer: a green plant that makes a simple sugar using water, carbon dioxide, and sunlight.

Regolith: a thin veneer of loose materials formed as rocks weather.

Residual soil: weathered fragments of solid rock.

Respiration: the heat-generating process of breaking down food.

Sedimentary rock: rock formed by layers of loose materials deposited by water, wind, or glacial ice. Examples include sandstone, shale, and limestone.

Sludge: the liquid, semisolid, and solid materials that are leftover from sewage treatment.

Soil: the loose surface material of the earth in which plants grow. Soil is made of organic and inorganic materials, although organic materials may leach out of lower layers.

Soil amendment: addition to the soil that improves its texture and fertility.

Topsoil: the surface layer of soil, including the organic material such as roots, etc.

Transported soil: soil made from fragments of rock carried by streams, waves, winds, or glaciers.

NOTES

BEST COPY AVAILABLE